A MANUAL OF
THE TIMBERS OF THE WORLD

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TORONTO

A MANUAL OF THE
TIMBERS OF THE WORLD

THEIR CHARACTERISTICS AND USES

BY

ALEXANDER L. HOWARD

TO WHICH IS APPENDED AN ACCOUNT BY S. FITZGERALD
OF THE ARTIFICIAL SEASONING OF TIMBER

WITH UPWARDS OF 100 *ILLUSTRATIONS*

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PREFACE

THE present book is not intended to supersede any of the works on timber hitherto published, but rather to supplement them. It has been put forward to meet a distinct want for a clearly-arranged handbook which shall contain information concerning all the timbers encountered in commerce, including those which have only of recent years appeared in the European market. The aim has been to treat the subject from its commercial, technical, and industrial aspects.

In compiling this work I have adduced the practical experience of over forty years' work in the timber trade. In all cases where I have had experience of the merits and characteristic qualities of the wood, the report is based on this personal knowledge. Where I have lacked this, I have taken extracts from the most recent reports of other authorities, and I am much indebted to them for allowing me to quote from their writings. These are noted in the bibliography.

I also wish to express my thanks to those of my friends who have so kindly given me their assistance. Amongst them I would name:

Professor Percy Groom, M.A., D.Sc., F.L.S., F.R.H.S., to whom I am indebted for valuable help in the botanical side of the work; Sir Hugh Beevor, Bart.; Colonel James Brown, D.S.O.; Mr. H. J. Elwes, F.R.S.; Mr. J. S. Gamble, M.A., C.I.E., F.R.S., F.L.S.; Mr. Arthur Gardner; Mr. Edwin Haynes; Mr. G. S. Hart, I.F.S.; Mr. J. Masters Hillier; Dr. Charles Hose; Major-General Sir Newton Moore, K.C.M.G., M.P.; Mr. B. Ohta; Mr. R. S. Pearson, I.F.S., F.L.S.; Mr. Hugh G. Saunders, and Professor R. S. Troup, F.C.H., and Miss Eleanor Rudwick who has greatly assisted me.

ALEXANDER L. HOWARD.

REGENT'S PARK,
August 1919.

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INTRODUCTION

Ao Viandante

Tu que passas e ergues para mim o teu braço, antes que me faças mal, olha-me bem.

Eu sou o calor de teu lar nas noites frias do inverno, eu sou a sombra amiga que tu encontras quando caminhas sob o sol de agosto, e os meus frutos são a frescura apetitosa que te sacia a sêde nos caminhos.

Eu sol a trave amiga da tua casa, sou a taboa da tua mêsa, a cama em que tu descanças e o lenho do teu barco.

Eu sou o cabo da tua enxada, a porta da tua morada, a madeira do teu bêrço e o conchego do teu caixão.

Sou o pão da bondade e a flôr da beleza.

Tu que passas, olha-me bem e . . . não me faças mal.

To the Wayfarer

Ye who pass by and would raise your hand against me, hearken ere you harm me.

I am the heat of your hearth on the cold winter nights, the friendly shade screening you from the summer sun, and my fruits are refreshing draughts quenching your thirst as you journey on.

I am the beam that holds your house, the board of your table, the bed on which you lie, and the timber that builds your boat.

I am the handle of your hoe, the door of your homestead, the wood of your cradle, and the shell of your coffin.

I am the bread of kindness and the flower of beauty.

Ye who pass by, listen to my prayer: harm me not.

So runs an inscription which in Portugal is displayed wherever, in woods, parks and gardens, timber trees are to be found. This notice sets forth in the concentrated vigour of its style an appeal whose necessity is urgent in other lands than Portugal. Apart from its artistic and sentimental aspect, its aim is threefold. It appeals for due precautions against the misuse of timber trees. It demands that proper and necessary care be taken to use timber to the fullest and best advantage. It calls for the recognition of the importance of timber trees in the multitudinous needs of the community.

In England these three considerations are but little regarded. The majority of our population show an indifference to the subject which is but the measure of their ignorance of it, while our educational and administrative authorities continue to neglect it in a manner which accounts for the general apathy.

This common lack of knowledge leads in many cases not merely to a passive disregard, but often to an active mutilation and disfigurement. Boys particularly, are prone to damage trees simply because they have not been taught to value them.

The forests of England have been a source of national safety and national prosperity in the past. A sea-faring nation whose history in the last three hundred years has been one of the imperial expansion of an island race, we owe it largely to our home timber supplies that our ships obtained this supremacy. Again, in the centuries before the general development of our coal deposits, it was the great Forest of the Weald that made the Sussex ironwork industry possible.

We see then that our national timber supply has been of the utmost value to us in the past. This is no longer so. The manner of our forest utilisation has been wasteful and without forethought. Whole areas have been denuded of trees which might have continued to give a supply of home-grown timber; while, as with other commodities, we have relied of late years to a needless extent upon foreign supplies.

An educational system which is adequate should rightly include some knowledge of the vital needs of the country, some realisation of the possibilities of our national resources. In our schools there is an almost complete neglect of that necessary function of education which should develop the child as a member of an economic community, giving to him a grasp of the material needs and resources of his country, and opening up before him avenues of industrial interest. Commercial geography does, for instance, claim to fulfil this function, but educational reforms need time before they can justify themselves, and the spread of modern methods of teaching geography upon these lines is all too slow. It is too often thought that disciplinary and humanistic subjects are necessarily divorced from those which are valuable commercially. This is unfortunate. There is no reason why science should not be more often presented in its commercial relations. At present the teaching of science and geography in our schools lays itself open to the old charge levelled against the classical tradition. It was urged that classical education was remote from life. It was said to touch no springs of living or material interest. It had no relation to modern needs. Might not the same be said with greater truth of much of the teaching of science in our public and secondary schools to-day? Is it not out of touch with living interests? Does it show constantly its close connection with industrial and commercial activities?

We have to face facts. Our boys are going out from their schools to earn their own livelihood. The commercial aspect of education is of the utmost importance to them. Then, to take a larger view, and one which is equally vital, they are going out to maintain and to build up a prosperous Empire. They have before them the task of developing our home resources and of supplementing these by an enlightened understanding of our needs of overseas supplies.

Here then we have a subject which in the past has been closely concerned with our national well-being, and which is no less so in the present, and yet it is one which is neglected in the teaching of science and geography in our schools. The subject of timber, its supplies both within and beyond our own Empire, together with its treatment and its possibilities is one full of interest in itself, and which might well be introduced, not as an isolated item upon an already over-burdened list of subjects, but in rational correlation with science and geography. We are now faced with a period of wide industrial change and novel development, when the natural resources of the world must be mapped out, and measures taken for their right use and conservation. The forests of five continents hold in themselves a vast portion of the world's wealth. Much of its value is so far unrealised. Timber has been put to a multitude of uses in the past, but latterly a belief was gradually gaining ground that it might be superseded by steel and concrete. This belief is groundless and mistaken, as we have clearly seen since the war. In many ways it is again being used instead of these substitutes, while further uses are being discovered for it every day. Certain woods essential in industrial developments and the making of engines of war, are finding new commercial values hitherto entirely unsuspected.

These considerations, though they may appear to be but generalities, have, however, a close practical application to the subject. If they have shown anything, they have shown that the time has come for the British Government to concern itself with a closer and better effect in the timber trade, both as regards the home supplies and the expansion of foreign trade. In the past it was the policy of the Government to maintain an attitude of *laissez-faire* with regard to industry, but opinion has now swung round to regard it as a normal function of Government to foster and assist all industries and trades necessary to the well-being of the community. The difficulties under which the timber industry labours should be removed. There should be adequate protection for woodlands, where, too frequently, valuable timber is ruined by wanton ill-usage, while *the present unreasonable freightage dues need readjustment that the* trade be not strangled.

It was seen during the European war how effective definite Government propaganda could be when it was necessary to enlighten the public upon matters which concerned its interest. This weapon, through the schools and in the press, could well be used for the benefit of essential industries. As an illustration of such wise action of the State, might be mentioned the fact that in America, in Australia, in Norway and in Portugal, the school children are taught to plant saplings in order that the timber supplies of these countries may not fail. In addition to protecting the industry and enlightening the public to its true interests in the matter, the Government should take every opportunity to encourage and foster it by providing information and advice in the form of wise forestry regulations. Such a policy has made a model to us of the forestry of France, Germany, Hungary and other countries. We cannot wish to see the number of our woodland areas decrease, when we realise the national and, indeed, the imperial importance of a fully sufficient reserve of timbered land. As far as may be reconciled with economic principles, the denuded areas should be re-planted and fresh trees introduced.

So much for the material and economic aspect of the subject of timber. From an æsthetic point of view it is full of attraction. The proud tops of the pine and the larch which clothe the northern and the western hills add to their sombre beauty, while the more intimate loveliness of the lowland coppices and stately parks, with their " firs and ashes, oaks and elms, the poplars and the cypresses," has given the poets inspiration for delicate imagery. To know something of the description and the uses of these familiar trees, as well as of the woods of more exotic beauty from the dark forests of India and Burma, from the sun-drenched islands of the eastern seas, from South America and from Africa ;—their marvellous diversity of colour, their exquisite scents, and the strange glamour of their very names, is to gain a new and never-palling interest in a comparatively little-known portion of the grand heritage of the heirs of this world.

CATALOGUE OF THE TIMBERS OF THE WORLD

Abey. *Poeppigia excelsa*, A. Rich. Weight, 50 lbs. 15 oz.[1] San Domingo.

This is a small, reddish-coloured wood much resembling mahogany or satinee, though generally perhaps more like the latter. It possesses a firm, hard texture and is of about the same strength as satinee, with the characteristic contrary grain of hard and soft lines found in that wood, though it is generally rather wider. In North America it has sometimes been called bay-wood. It is probable that it has been used in the United Kingdom as both satinee and mahogany, especially in old pieces of artistic furniture. It is capable of a fine finish when sharp tools are used. For turnery, mouldings, show-cases, and furniture of all kinds it is very satisfactory, and it stands well under all conditions.

The pores are irregular in size and position, and sometimes appear in duplicate and triplicate ; they show on the tangential section a fine mark like chalk, which is similar to the marking of San Domingo and some Cuban mahogany. The medullary rays are clearly defined, parallel, and irregular, and are joined at right angles by sparse and rather faint similar lines.

Abey Macho. *Hedwigia balsamifera.* The West Indies.

Little is known of this wood, though it is possible that it may at times have been mixed with the supplies of abey.

Acacia. *Robinia Pseudacacia*, Linn. Weight, 40-50 lbs. Europe, America.

This species of tree, usually known in Great Britain as the "locust tree" or "false acacia," is a native of North America, whence it was introduced into Europe, over which it is now widely grown. It has also been planted in Japan and in the Himalayas.

The timber has not been imported into England commercially, and, strange as it may seem, is not in demand, very few if any of those customarily using timber asking for it. The heart-wood when fresh and planed is light greenish-yellow, and shows a glossy lustre and a hard, bright surface, but it subsequently darkens to a dull greenish-brown. It is one of the number of valuable woods that we possess at our doors yet use so little; in France, however, where the economic utilisation of wood is practised, this timber receives the full attention that it merits for various purposes. It vies with, and in some cases surpasses, European oak in strength and durability, is tough and very elastic, and has considerable powers of resisting shock. Its marked durability in contact with the ground renders this timber excellent for all outdoor work, such as posts, rails, trenails, and so forth. On Sir Hugh Beevor's estate, for instance, a large plank was used as a bridge for forty years, when it was carried away by floods; and posts for palings have remained sound in the ground during more than thirty years. Elwes and Henry quote cases of posts that were still sound after eighty years. On this same subject of durability Stone quotes several authorities as follows: . . . "almost incorruptible, stronger and more durable than oak, very elastic and of a vertical resistance one-third greater than oak; the best wood for spokes."

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[1] The weights given are in all cases the weight per cubic foot when dry.

In recent times the wood has been employed, especially on the Continent, in the manufacture of spokes for the wheels of motor cars. Very carefully selected wood has been found to be excellent for this purpose, but in some cases the employment of defective (so-called "dead") specimens of acacia wood has resulted in serious accidents. British-grown acacia has been used occasionally in old furniture, and will compare favourably with satin-wood for such work. Exposure to light and air has improved the colour, and it is often mistaken for the latter wood. This was the case with a small bureau owned by Mr. Edgar Taylor, which had been considered to be satin-wood, as it resembled that wood in its beautiful colour and texture. Recent examination, however, has proved it to be acacia.

Especially worthy of note is the exceeding narrowness of the sap-wood, which includes only from two to five annual rings. Moreover, during the first twenty-five to forty-five years of its life the tree grows fairly rapidly. The consequence of these two facts is that a comparatively young tree yields serviceable timber. One specimen which I planted thirty-eight years ago is now (1919) large enough to supply wood sufficient to make three sturdy gate-posts or legs for half a dozen chairs. The "false acacia," with its graceful habit and beautiful pendent tassels of white flowers, deserves to be widely planted for both its beauty and its utility.

The pores forming the pore zone are large, but all, except in the sap-wood, are plugged with microscopic cists (thyloses). The medullary rays are fine, but just visible to the naked eye in transverse section.

Acacia Catechu, Willd. Weight, 65 lbs. India, Burma.

The native name of the timber is " khair," while it is sometimes known as the " cutch tree." The wood is a bright red mahogany colour, is slightly lustrous, and has a close, firm, hard texture. It is a valuable cabinet wood, possessing the well-known qualities and appearance of Spanish mahogany. Gamble says that it seasons well, takes a fine polish, and is extremely durable. He also includes it in his list of woods which are available in fairly large quantities.

The pores, which are generally surrounded by a white halo, are of moderate size. The medullary rays are clear and distinct but vary in fineness.

Acacia leucophloea, Willd. Weight, 58 lbs. India, Burma.

The wood of this fairly large tree is reddish-brown with lighter and darker streaks. It is hard, strong and tough, and seasons and polishes well. It is obtainable in squares about 20 feet x 10 inches x 10 inches, and is used for posts and beams, carts, wheels and ploughs, and also for smaller work such as turning.

ACANA. Source unknown. Weight, 65 lbs. Cuba.

In 1915 a few logs, hewn square, ranging from 10 to 24 feet in length and 12 to 15 inches in thickness, were imported into Liverpool under the name of " acana." The timber is hard and dense, and acquires from the tool a smooth, marble-like surface.

It is of a deep, dull, purple-plum colour, and shows a strong resemblance to beef-wood. Some of the logs were well marked with mahogany-like roe and mottle figure. After planing the wood seems inclined to split. A considerable proportion of the logs had been rendered worthless by the attacks of a species of very small " worm " or beetle, which bored more especially along the medullary rays and parallel with the concentric growth-layers. The damaged wood emitted a strong unpleasant odour suggesting putrefaction.[1]

The pores are small and somewhat obscure. The medullary rays are very fine and closely packed, and are linked at right angles by similar but more strongly marked white lines.

ACAPU. Source unknown. Weight, 63 lbs. Brazil.

This most valuable Brazilian timber agrees in general colour and somewhat in appearance with dark teak, but being streaked along its grain with alternate lighter and darker lines, it displays a stronger likeness to partridge wood. It does not split, yields a fine surface from the tool, and stands well. The surface is sticky, which is probably due to oily contents. The wood has a peculiar and unpleasant scent, though Weisner describes his sample as exhaling a fragrant odour recalling that of the cigar-box cedar (*Cedrela odorata*). This timber could probably be used as an excellent substitute for teak, although it might be heavier and harder to work.

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[1] Three logs of Cuban wood called " almique " have been imported into London, and the wood appears to be the same as the above-named.

The pores are not very open. The exceedingly fine medullary rays in cross-section are invisible to the naked eye, but with the magnifying glass are clearly defined by reason of their light colour; they are linked at right angles by similar light lines.

Adenanthera pavonina, Linn. Weight, 56 lbs. India, Burma, the Andaman Islands.

A dark, reddish-brown wood, this displays a pretty wavy pattern on the radial section. It would be useful in this country, as it already is in India, for cabinet work. It has not yet been imported commercially, but supplies are likely to be available in the near future.

"Pores small, scanty, in groups or short radial lines. Medullary rays very fine, extremely numerous." (Gamble.)

ADERNO. *Astronium commune*, Jacq. Brazil.

This timber, which is also known variously as chibatan and ubatan, is described by Baterden as being of a red colour. It is used, according to *Brazilian Woods*, in building work and for railway sleepers, and the same authority speaks of it as having a very close grain.

Adina cordifolia, Hook, f. Weight, 45 lbs. (Gamble). India, Burma, Ceylon.

The wood, which in India is called haldu, is of a dull yellow colour with a reddish tinge, like a dull satin-wood. It has a close, firm texture, and it is capable of a very smooth surface. It has been imported to a limited extent, and has been found very useful for brushwork. If a regular supply was established there is no doubt the demand would continually increase, as it is a wood having unusual qualities which fit it for special uses. The evenness of the grain is very pronounced, so that it can be cut either with or across the grain equally well, and on this account it should be a valuable wood for carving. The colour being so flesh-like, would specially fit it for the carving of statues. It stands well under all conditions, and would be very suitable for cabinet work and all decorative purposes. Gamble reports it as "Good for turning, and extensively employed in construction for furniture, agricultural implements, opium and cigar-boxes, writing tablets, combs, and numerous other purposes." It has been found to be an excellent wood for bobbins.

This is one of the timbers mentioned on Mr. Gamble's list of woods which are available in fairly large quantities, and are likely to be worth trial.

The exceedingly numerous pores are very small indeed. The medullary rays are so fine that it is difficult to see them through the lens. (12 ×.)

Aglaia Roxburghiana, W. and A. Weight, 58–61 lbs. India.

The colour of this wood is bright red. It is hard, close-grained, and handsomely marked. It is reported as being strong and standing well.

"Pores small, scanty, in narrow rings of whitish tissue which run concentrically and appear on a cross-section as narrow wavy lines. Medullary rays fine, numerous, evenly distributed; the distance between them equal to or less than the diameter of the pores." (Gamble.)

AILANTHUS. *Ailanthus glandulosa*, Desf. Weight, 38 lbs. 9 oz.

This tree, familiar under the name of "Tree of Heaven," is a native of China, from which it has been introduced into England and the continent of Europe.

The timber, which is neither well-known nor much used, resembles in colour and grain that of the ash to such an extent that it is often mistaken and substituted for it. Careful tests made by the engineer, G. Lauboeck, showed that his samples of this wood surpassed timber of the ash grown on the Continent in resistance to rupture by bending, and that it possessed a high degree of elasticity and resistance to crushing. In view of published statements opposing these results, and considering the rapid extension of the cultivation of the tree in England, renewed tests as to the properties of its timber are desirable. My experience, however, is that it does not possess the strength of English ash.

The annual rings are clearly marked; they are easily identified because of the spring-zone of wide open pores. The wood is easily distinguished from that of the ash, not only, as is usually the case, by the great width of the annual rings, but also by the fact that the medullary rays are easily visible in cross-section to the naked eye.

AKEAKE. *Olearia aricenniaelobia*. New Zealand, South Island.

Only a very small quantity of this timber has ever been seen in England, but further shipments would be appreciated. The New Zealand Department of Agriculture reports the wood as "yellowish, with a satiny lustre, frequently wavy and prettily figured; obtainable in short lengths and small in size. Used for ornamental cabinet-maker's work, inlaying, etc."

Albizzia odoratissima, Benth. Weight, 54 lbs. India, Burma.

This large tree yields squares 30 feet × 12 inches × 12 inches. The wood is dark brown in colour; it is fairly durable, and seasons, works, and polishes well.

Professor Unwin recorded the following results of tests:

Resistance to shearing along the fibres	1283 lbs. per sq. inch.
Crushing strength	4·184 tons ,,
Transverse	6·518 ,, ,,
Co-efficient of elasticity	755 ,, ,,

The wood is used for building, shafts and axles of carts, wheels, ploughs, and casks, and also for furniture.

Albizzia procera, Benth. Weight, 39–40 lbs.; (average of Gamble's specimens, 46 lbs.). India.

The produce of this tree, known in India as white siris, is entirely unknown under this name in the United Kingdom. It is probable that it has been imported, mixed with the produce of *A. Lebbek*, and called East India walnut. It would certainly deserve the name of walnut better than the latter, as it more nearly resembles the European or American walnut in all respects, and, unlike *A. Lebbek*, would undoubtedly make a good substitute for them. If any quantity became available, it would soon become known and in demand.

The wood is of a brown walnut shade, tinged with red or yellow; it is lustrous and bright and inclined to be streaky, but without the dark lines which are characteristic of European walnut. The sap-wood is not durable. The wood is often straight-grained and mild, although much of it is highly figured, and it stands remarkably well under all conditions. Gamble reports it as "straight and even-grained, seasons well, and the heart-wood is durable." It is used in India for a variety of purposes, which include wheels, agricultural implements, bridges, and house-posts. It should, however, be suitable for rifle and gun stocks, as it possesses all the required qualities.

The pores are scarce and rather large and open, with smaller ones which are occasionally plugged. The medullary rays are fine, and show very clearly in the radial section, as in sycamore.

ALDER. *Alnus glutinosa*, Gaert. Weight, 26–41 lbs. (Stone).

Although this species of tree is widely distributed in temperate Europe, Asia, and North Africa, in an area extending from the British Isles to Japan, the timber used in Great Britain is almost entirely of British growth, an exception being provided by ply-wood, which is imported.

The wood is reddish-white, soft and light, and possesses a smooth, fine grain. It has a somewhat soft yet tough surface, which is rubber-like and resilient, so that a light blow causes a temporary depression unaccompanied by any considerable permanent indentation. It is used in the manufacture of clogs, soles of shoes, and toys, and also in turnery and the cheaper forms of cabinet work. Being extremely durable when wholly submerged, it has provided the material for drain pipes, sluice-gates, and so forth ; in fact, Holtzapffel states that the piles of the Rialto at Venice were composed of this wood. In America it has been used in the manufacture of combs. Alder charcoal has long been employed in the manufacture of gunpowder. Recently it has been used in large quantities for ply-veneer of all kinds, and especially for trunks, tea-boxes, packing-cases, and the like. Still more recently such ply-veneer has been forthcoming from Japan, where wood of excellent quality, though slightly redder than European alder, is found. Since its utilisation in this connection there has been a good demand for alder, which, however, is a serviceable wood for which much profitable employment could be found if its proper uses were more studied. Very handsome card-cases and cigarette cases, for instance, have been made from dark-grained, richly figured, gnarled pieces.

The annual rings are distinct in cross-section ; the pores are invisible to the naked eye, as are most of the medullary rays, but some of the latter aggregated form dull-edged " false rays." Pith flecks are present.

ALDER, FORMOSAN. *Alnus maritima*, Nutt., var. *formosana*, Burhill. Weight, 33 lbs. Formosa.

The wood is of a light-yellow straw colour ; it has a bright sheen, and takes a smooth surface. It is streaked with thin, reddish lines caused by the medullary rays, which show very strongly on the radial section, as in oak. It has a very good texture, and gives every promise of standing well without liability to warp or twist. It has never been imported into England, but would be very useful for a great number of purposes. Mitsui & Co. report that an available supply of one million and a half cubic feet exists.

The pores, which are very numerous, are small, and the medullary rays are strong and clearly defined, with a number of secondary smaller rays between the stronger and principal ones.

ALERCE. *Fitzroya patagonica*, Hook. Weight, 28 lbs. South America.

This wood has the characteristic grain of the thuya and cypress, and is of about the same weight. In colour, however, it is of a reddish hue, deepening with exposure to light and air to a brilliant rich, warm red, with alternate lighter and darker streaks. It is easy to work, and is capable of a smooth surface from the tool, and it stands well in all conditions. It is not known commercially in the United Kingdom, but it would undoubtedly be in demand for a great variety of decorative and other work, if any regular supply was available, especially as it is reported as being very durable.

The concentric layers, which are strongly defined, are very close, giving the. appearance of a very slow-growing wood. The pores are variable in size, and the medullary rays are clearly marked, and only show obscurely on the tangential section.

ALMOND, EUROPEAN. *Prunus Amygdalus*, Stokes; *Amygdalus communis*, Linn. Weight, 43 lbs. Europe.

The colour of the wood is dull reddish-brown with darker veins. It is of but slight commercial importance, though it finds occasional use in turnery and the fashioning of marquetry.

The medullary rays are well marked, and the pores, except in the pore zone, are very small.

ALMOND-WOOD. Source unknown. Weight, 42 lbs. 12 oz. Cuba.

In the year 1900 a shipment consisting of a considerable number of large logs hewn square and measuring over 36 inches, arrived in the London Docks from Cuba, and was sold under the name of "Cuba almond."

In texture, weight, and general character it resembled Cuba mahogany, but differed greatly from this in its colour, which was greyish-brown, irregularly marked with bluish streaks. All the logs displayed a more or less wavy and curly grain, with those forms of rich figure that are commonly known as roe and splash mottle. Some of this marking was so extremely decorative that the wood was in constant demand for fine veneers, which gave a very handsome effect when polished. Most of this was sent to America. Since that date, however, there have been no further supplies.

The pores are large and open and somewhat scattered. The medullary rays are not very clearly defined. The pores in the tangential section show lustrous contents.

Alphonsea ventricosa, Hook, f., and Th. Assam, Chittagong, the Andaman Islands.

The wood is a dull yellow with occasional dark streaks. It is close-grained and strong. Gamble, quoting Heinig, says that it is used in boatbuilding, and squares up to 30 feet by 15 inches.

AMARANT or AMARANTE.

This name is sometimes applied to a wood that is certainly identical with true purple and purpleheart (*q.v.*) obtained from British Guiana (Demerara) and Dutch Guiana (Surinam). In France, however, a distinction is drawn between purple and red amarante, so that the same name is applied to a red wood of unknown origin resembling a padauk (*Pterocarpus*) or sabicu.

AMBOYNA. Source unknown. Weight, 39 lbs. Borneo, the Moluccas.

The name Amboyna, or kiabooca wood, is applied to certain burrs imported from the Moluccas (including Amboyna) and Borneo. Whether these are all derived from the same species of tree is unknown; various writers attribute them to species of *Pterocarpus* or *Pterospermum*, or to a member of the mahogany family (*Flindersia* ?).

The wood is brown, tinged with yellow or red, but changes with age to a dull-brown leather colour. It is marked with little twisted curls and knots in a manner similar to but more varied than bird's-eye maple. With the naked eye it is difficult to distinguish between the burrs of Amboyna-wood and thuya, or even, according to some authorities, of yew; but though the burr-wood of the yew is similar to that of the other two as regards colour, it nevertheless is unlike them in all other respects. Amboyna-wood has been freely utilised in the manufacture of ornamental furniture, especially during the Empire period (1804–14), but after this time its use gradually declined. Quite recently, however, a revival took place on the Continent, particularly in Paris, where a considerable quantity of fine burrs has been converted into veneers and employed in making up costly furniture and interior decorations in motor-cars.

Under the name of "false Amboyna-wood" there have recently reached Paris some very fine burrs, which measured up to 3 feet in length and 20 inches in width. With the naked eye it is almost impossible to distinguish these from true Amboyna-wood, with which, however, they contrast by their strong and variable, either pleasant or unpleasant, scent. It has not been found possible to trace either the geographical or the botanical source of these burrs. Possibly they may belong to one or more species of *Dipterocarps* growing in French colonies.

AMLA-KA. *Phyllanthus Emblica*, Linn. Weight, 52 lbs. India, China, Japan.

Gamble speaks of this wood as being "red, hard, close-grained, warps and splits in seasoning, no heart-wood. . . . A pretty and ornamental tree, but of not much importance. . . . The wood makes good poles, and is useful for agricultural implements, building, and furniture: it is durable under water and can be used for well-work.

"Annual rings not distinct. Pores small and moderate-sized, uniformly distributed, often subdivided or in short radial lines. Medullary rays moderately broad, the distance between two rays generally greater than the transverse diameter of the pores; silver-grain prominent."

ANGELIM-ROSA. *Peraltea erythrinaefolia*, Mart. Brazil.

This is a brown-coloured, porous wood, strong and moderately heavy. It is used for beams in shipbuilding, in carpentry, and in the domestic arts. *Brazilian Woods* speaks of it as being an excellent wood for building and submerged works owing to its durability.

ANGÉLIQUE. *Dicorynia paraensis*, Benth. Weight, 53 lbs. French Guiana.

This tree is of a straight growth and yields timber 12 to 22 inches square by 20 to 54 feet in length, clear of branches. The wood is of a reddish-brown colour, clean and even in the grain, moderately hard, tough, strong, elastic, and not difficult to work, although it does not cleave readily. Occasionally a few logs are found with a waviness or figure in the grain, which would make them valuable to the cabinet-maker. There is little sap-wood. The timber is very sound and free from knots, and except that a small percentage of the logs have a slight heart-shake, or perhaps star-shake, at the pith or centre, there are no defects affecting the conversion of it into planks and so forth. It has been said that it does not rot in water, that it is proof against attacks from many insects to which other timber is liable, and that it is durable. Occasionally it is found that in working some of the logs emit an unpleasant odour.

For some reason the import of this timber has now entirely ceased, and supplies have not been seen in England for some years. Beauverie states that the wood finds little use in France because it is supposed to cause nails to rust.

Three varieties of angélique, black, red, and white, are distinguishable, but the description here given concerns the brownish-red kind.

The wood shows no distinct annual rings. Its pores are large, scattered, and not numerous; they contain a white or reddish, opaque glistening substance. The medullary rays are very fine and are invisible; they are joined at right angles (in cross-section) by many shorter or longer light, wavy, concentric lines which are just visible to the naked eye, and show independently of the pores, though here and there linking with these. The tangential view reveals, even to the naked eye, beautiful *tiered structure* or ripple marks, which are especially distinct on the lighter coloured wood, and resemble in miniature the ripple marks on a sandy shore or the patterns in finger-prints.

ANGICO. ***Piptadenia rigida***, Benth. Weight, 71 lbs. Brazil.

This timber is described in ***Brazilian Woods*** as being of excellent quality for building and naval architecture.

ANJAN. ***Hardwickia binata***, Roxb. Weight, 82 lbs. (Troup). India.

This is a very valuable wood which should be imported into the United Kingdom and used for many important purposes. It appears to possess the very durable qualities of pyinkado (*Xylia dolabriformis*) without the oily or sticky surface which the latter possesses, which quality, while doubtless making it more durable, also renders it less suitable for cabinet and decorative work. Anjan is capable of a very smooth surface from the tool, almost, as R. S. Troup says, making it comparable with African blackwood (*Dalbergia Melanoxylon*). The same author recommends it for turnery. It would be invaluable in those parts of decorative cabinet work where a hard, smooth surface is required, and where an undoubted good standing wood, which will neither shrink nor warp, is necessary. Its qualities as a decorative wood are further enhanced by its handsome colour and appearance.

In colour it varies from brick-red to a dull dark brown with black streaks. It would give much the same appearance in finished work as that which can be obtained in Italian walnut work. Unfortunately, in common with so many valuable Indian timbers, it has no European name, nor has it yet been imported in commercial quantities. One log was sent to the Imperial College of Science and Technology, South Kensington, a few years ago, and can be seen there.

The pores are regular and uniform in size and position. The medullary rays are very faint and obscure even under the lens (12 ×). There is a small, faint ripple mark on the radial section.

Anogeissus acuminata, Wall. Weight, 50 lbs. India, Burma.

The wood is yellowish, fairly hard, and not particularly easy to season and work. It is, however, quite suitable for rough purposes under cover. It would certainly yield much better timber if it were artificially seasoned. Logs are obtainable 30 feet × 12 inches × 12 inches.

Anogeissus latifolia, Wall. Weight, 62 lbs. (Gamble). India.

The colour of this wood is a pale greyish-yellow; it is very similar to bleached hare-wood, the genuine hare-wood, that is, and not the stained sycamore which commonly passes for it. The wood has a close firm grain, which is somewhat akin to that of satin-wood. A considerable portion of the supplies produce well-figured pieces with what is known as the splash-mottle effect.

Although little known hitherto in the commercial world, supplies may be expected in the future, when it will probably become highly valued for first-class decorative cabinet work, and particularly for chairs.

The pores are numerous and regular, and are joined by wavy belts of light lines forming a very pretty pattern. The medullary rays, which are fine and clear cut, are exceedingly numerous and parallel and are almost equidistant.

APITONG. *Dipterocarpus grandiflorus*, Blanco. Weight, 44 lbs. 1 oz. Malay Peninsula, British North Borneo, the Philippines.

This timber was first imported into London and Liverpool in 1915, and has been received in the form of sawn planks and boards 10 feet and upwards in length, 8 inches and upwards in width, generally fairlv wide, and up to 6 inches in thickness.

Foxworthy described the wood as being " a pale greyish-red, sometimes with a faint purplish tinge." The imported wood is of a dull reddish-brown colour with resin-plugged pores; it much resembles the timbers of many other dipterocarps. It is, however, lighter in weight, appears to be deficient in elasticity, firmness, and strength, and is liable to warp and twist. As the number of species of the dipterocarpus family yielding timbers reaches more than three hundred, and as they are often very similar in appearance, though of widely different qualities and values, each sample or shipment should be examined with care.

The sample examined shows concentric layers marked out by the occurrence of bands containing few pores. The pores are scattered and large, and are easily visible to the naked eye. The medullary rays, just visible in transverse section, produce on the radial section a beautiful silver grain as they stand out from the lighter groundwork in brownish-red glistening bands.

APPLE. *Pyrus Malus*, Linn. Weight, 48 lbs. 3 oz. Europe.

The heart-wood of apple is hard and reddish-brown, while the sap-wood is light red in tint. When thoroughly seasoned it stands well, but is very apt to warp and split during the process. It is used for a variety of purposes, these including cog-wheels and turnery, and it might perhaps be utilised to make the heads of golf clubs.

The annual rings are recognisable, though not marked; both pores and medullary rays are invisible to the naked eye.

ARARIBA AMARELLO. *Centrolobium robustum*, Mart. Brazil.

This is a light-coloured wood, with a clean straight grain.

It is described in *Brazilian Woods* as being bright yellow with a gold-tinted grain, and used for building and naval architecture and fancy woodwork.

This authority also notes a wood of the same species, ARARIBA VERMELHO (*C. tomentosum*, Benth.), which is a bright red wood with a dark grain, and is used for similar purposes.

ARAUCARIA. *Araucaria imbricata*, Par. Weight, 20 lbs. 1 oz. South America.

This tree, familiar in English gardens under the name of "monkey puzzle," is a native of Southern Chile. The wood, in colour and grain, resembles a very mild, straight-grained deal (*Pinus sylvestris*), but shows a smoother surface and has no resin-passages. The timber has not been sufficiently tested in this country to permit of definite statements as to its uses. The trees grown in England would also yield wood with too many faults, due to the rosettes of knots which represent the clusters of branches, so that it could not be used for work requiring strength, or where long lengths free from defect were needed. In other respects the timber would be useful in joiners' work.

Being a coniferous wood the pores and the medullary rays are not distinct in the transverse section, though, especially near the pith, a radiating pattern is observable.

ARBOR VITAE. *Thuya occidentalis*, Linn. Weight, 19 lbs. (Gibson). North America.

This soft coniferous wood is seldom encountered in commerce. Gibson (*American Forest Trees*, p. 97) says that "the wood is soft, brittle, light and weak . . . very inflammable. The fact that it is durable even in contact with the soil permits its use for railway ties, telegraph poles, posts, fencing, shingles, and boats."

AROEIRA DO SERTÃO. *Astronium urundueva; Myracrodon urundeuva*, Fr. Allem. Weight, 79 lbs. (Baterden). Brazil.

The handbook *Brazilian Woods* says that this is one of the best woods in Brazil, and that it is used for building and hydraulic works as well as for joinery. Baterden describes it as a tawny-coloured wood with red markings. He adds: "It stands variation of temperature and wet and dry well . . . is valuable for all wearing surfaces such as brake blocks. The logs are small. [It is] one of the first-class sleeper-woods of Bahia, where it has a life of sixteen years."

Artocarpus Lakoocha, Roxb. Weight, 40 lbs. India, Burma, the Andaman Islands.

This wood, which is highly prized in the Andamans, is of a golden-yellow to orange colour. The very large pores somewhat detract from the appearance in the tangential and radial sections. It would be very suitable for furniture. Gamble notes that the wood is said to be difficult to saw on account of a resinous substance, but it is easy to plane.

ASH, AMERICAN. *Fraxinus americana,* Linn.; *F. sambucifolia,* Lam., etc. Weight, 42 lbs. America.

The wood is derived from a number, up to ten, of different species of ash. The produce of these is mixed together without any attempt at sorting the different kinds, which vary greatly in their qualities. It is thus impossible to secure timber of any standard quality. Occasionally, however, small supplies equal to British or Canadian ash have been imported into England. As a rule the wood is not so white as these two latter. Yet the best kinds rank with, and are difficult to distinguish from, the best English ash. For instance, a frame of American ash remained perfectly sound and was very hard after it had been in continual use for thirty-five years in an old horse-car on the London tramways.

Immense quantities of logs, boards, and planks have been imported into England for a number of years, and the timber has found its way into general use for every kind of purpose for which ash is used. Latterly the greatest demand has come from motor-carriage and waggon works. Although a very small percentage of supplies yield wood strong enough, yet during the war it was condemned for use in aeroplane construction.

Both the pores and medullary rays are larger and coarser than in the British ash, although in general character the growth is the same.

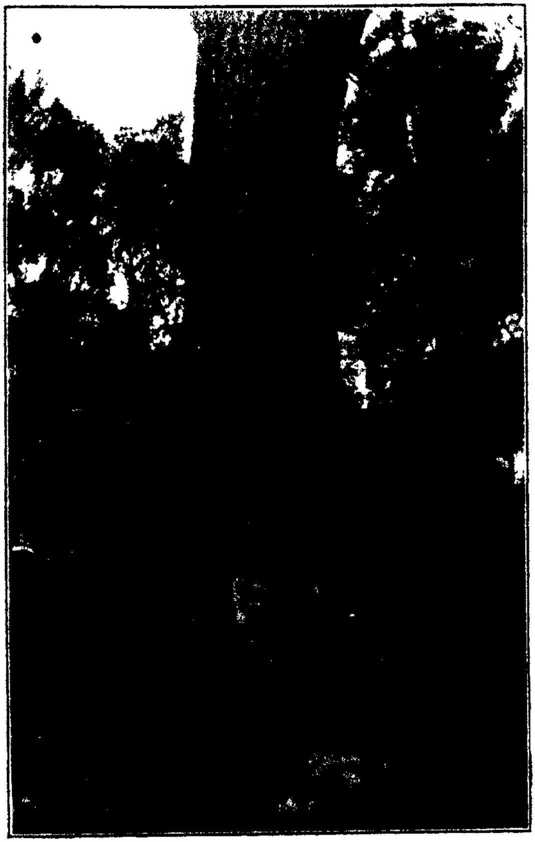
ASH, CANADIAN. *Fraxinus* sp. Weight, 41 lbs. 14 oz. Canada.

This wood is perhaps equal to British ash in quality, and some of it may even be stronger. It is in demand for making oars for the Royal Navy. Supplies, however, are daily decreasing.

ASH, EUROPEAN. *Fraxinus excelsior,* Linn. Weight, 46 lbs. 14 oz. Europe.

The common ash tree is widely distributed over Europe and supplies the English, French, Hungarian, and Turkish ash timber of commerce.

(*a*) ENGLISH ASH. Weight, 47 lbs.—The wood is greyish-white in colour, of moderate weight and hardness, very even and close in the grain, tough, elastic, and easily worked. Owing to its great flexibility it can never be safely used in architectural work. For hoops and all kinds of agricultural implements, however, it is invaluable, since when steamed it can easily be bent into any form of curve required without injury to the fibre. Ash is extremely durable if felled in the winter months and properly seasoned before use; but where these precautions are neglected few woods are more perishable. Very great advantage will be found in reducing the ash logs, soon after they are felled, into planks or boards for seasoning, since, if left for only a short time in the round state, deep shakes open from the surface, which involves a very heavy loss when brought on later for conversion. The advantage of converting ash logs into planks and so forth at the earliest possible moment after felling cannot be overestimated.



A Large Ash Burr after digging out.

Among English woods, ash is without equal for toughness and power of withstanding sudden shock. The finest English ash is sought for to make hockey sticks, tennis racquets, gymnasium poles, and other athletic appliances. Since the advent of the automobile it has been greatly in demand for framing, pillars, and general construction of bodies of motor-carriages, and also for the general woodwork of the hoods.

As a result of the great impetus given to the manufacture of aircraft on account of the war, supplies of English ash for use in this connection became of the greatest importance. The best wood obtainable was, in the early stages, used for spars and langerons. Very soon, however, the employment of ash for spars was largely discontinued, silver spruce and other woods being used in its place. For langerons it retained its position of importance, and nothing has yet been found so suitable for this purpose. Later, when the construction of aircraft of all kinds and sizes became necessary, it was found to be the best wood for the keel pieces of the gondolas, and for some of the other constructional parts, such as the ribs. An enormous number of pieces were required up to 32 feet in length, with straight and even grain throughout the whole length, and entirely free from the slightest defect. These were forthcoming, and it would perhaps be impossible to overrate the important part which a sufficient supply of this exceptional wood played in our efforts, which subsequently proved successful, to obtain command of the air. At a comparatively early date in the war the Air Board realised the great importance of securing a regular and adequate supply, and large contracts were placed all over the country. Even then it was not considered that sufficient quantities of the right material would be secured, and one of the officials of the Air Board originated a scheme to solve this problem. An organisation known as the " Aerial League " was formed, one of the functions of which was to approach every landowner throughout the country with the object of securing from him at a moderate price the whole of the ash trees growing on his estate which could be used for aircraft purposes. The immediate result was an almost universal acceptance of the scheme. Accordingly within a short time large numbers of suitable trees were cut down, promptly converted to the required thicknesses, artificially dried, and speedily manufactured into aircraft. It would not be an exaggeration to say that timber which was growing in this country was within a few weeks actually a part of aeroplanes which were then flying over the German lines in Flanders.

As has already been said, ash is always a difficult wood to season; nevertheless, under the impulse of necessity and the use of the most scientific methods of artificial seasoning, success was achieved. Indeed the artificially seasoned product showed, on the whole, better results than were obtained from the naturally seasoned wood which previously had alone been obtainable. The effect of the large demand made on the resources of the country in this respect during the war must be felt in the future, and it is to be hoped that such measures will be taken as will ible a fresh reserve of the best possible growth of ash to be built up the future.

During the progress of the war a considerable number of trees were in France and brought to London and elsewhere, a feat which in itself vorthy of note, as demonstrating the transport resources of this country l its command of the sea. The quality of this ash produced in France ler the superior French forestry system, when compared with the lity of that grown in this country, with its lack of any such adequate tem is most detrimental to the English wood.

The tree has a very wide sap-wood (about forty annual rings to the h) which is yellowish or greyish-white, and the heart-wood is light rown. The annual rings are rendered very distinct by the spring zone of large pores. The medullary rays are scarcely recognisable to the naked eye in transverse section.

The Ash Burr ready for carting away

(*b*) French Ash.—This wood is similar to English ash, but is generally milder and less strong.

(*c*) Hungarian Ash. Weight, 47 lbs. 13 oz.—Only a limited amount of this brownish-white to pure white wood has been imported into England, and this chiefly in the form of butts specially selected for their wavy, curly grain. For the sake of the handsome figure this type of wood has been eagerly purchased at high prices in order that it might be converted into veneers for decorative panel work in railway carriages and for furniture. Of late years, however, little of this genuine Hungarian ash has been procurable in England, most of that which is sold under this name being American in origin. A certain quantity of small, tough young trees with the bark on have been regularly imported from Transylvania, and used to supplement the supplies of home-grown ash for making billiard cues, for which the Hungarian wood is specially suitable. Although it is almost impossible to distinguish between the Hungarian and English grown timber when first cut, it can generally be identified after long exposure to light and air, as it then assumes a greenish-yellow tint not unlike that of acacia wood.

The pores are very numerous and irregular; they are generally small, and form a ripple pattern in the autumn wood. The medullary rays are very fine and numerous.

(*d*) SOUTH RUSSIAN and TURKISH ASH.—This timber is nearly white, but almost invariably contains a small black heart. It is difficult to distinguish from the English wood, and is strong and tough. The use of the timber has been restricted by the fact that it has been imported only in sizes smaller than can be readily obtained from other sources. The trees have been imported in the round with the bark on, and ranging in diameter from 10 to 20 inches at the butt end and in length from 8 to 21 feet. The wood has proved to be of a fine, strong, elastic quality.

ASH, JAPANESE. *Fraxinus mandschurica*, Rupr. Weight, 34 lbs. 10 oz. Japan.

During the last few years very large quantities of this fine and exceedingly useful timber have been imported into London and Liverpool. It is known in Japan by the name of "Tamo." The first shipments arrived about 1908. Messrs. Mitsui & Co. imported by far the largest quantities, although some shipments came from other sources. The imports of this firm were as follows:

1908 . .	13,181	cubic feet.	1913 . .	...	cubic feet.
1909 . .	1,002	" "	1914 . .	22,829	" "
1910 . .	...	" "	1915 . .	12,525	" "
1911 . .	387,434	" "	1916 . .	53,170	" "
1912 . .	...	" "	1917 . .	62,940	" "

This gives a total of over 500,000 feet, or over 11,000 loads.

The above figures are conclusive evidence of the popularity of this timber. Sargent (*Forest Flora of Japan*, p. 52), says: "*Fraxinus mandschurica*, which is common in Manchuria, Saghalien, and Corea, is a noble tree in Yezo, where it is exceedingly abundant . . . and where it often rises to the height of one hundred feet, and forms tall, straight stems three or four feet in diameter." The timber has been imported in square, hewn logs, sawn planks, boards, etc., and selected figured flitches and roots, with a small quantity also of prepared floorings. When first imported it was mixed with a quantity of timber sold as Japanese ash, but which was soon discovered to be quite a different wood. This proved to be the product of *Acanthopanax ricinifolium*, S. and Z., and known in Japan as "Sen," a timber which, although resembling ash in the grain, possesses none other of its qualities. This timber, being light in weight, having little or no strength and being specially short-grained, gave Japanese ash a very bad name at the outset. As soon as the discovery was made, steps were taken to ensure that shipments of Japanese ash consisted exclusively of the product of *Fraxinus mandschurica*, and, as has been mentioned, large quantities have since been imported.

The wood is generally lighter in weight and browner in colour than British ash. The colour is detrimental to its use for some purposes. As the wood is relatively strong, its weight, which averages about 10 per cent less than British, and 6 to 8 per cent less than American, is a great advantage for many purposes. The timber is really stronger than its weight and appearance would suggest. This is partly due to the closeness of the concentric layers, which give nearly three times the number of rings to the inch of circumference. The conditions under which it is shipped make it impossible to select the stronger growth from the milder. The variations in the strength of the British wood are well known, and the workman requiring the strongest and toughest ash would not seek for it among large, park-grown trees, knowing well where to find the growth required. In Japan, however, the produce of all the growths becomes mixed before shipment, and as it is impossible to determine where or how the timber has been grown, selection for toughness becomes difficult. There is undoubtedly a large percentage of exceedingly tough, strong wood.

Experiments for the purpose of testing the transverse strength were made with the following results:

No. 1 broke at 2,968 lbs.
No. 2 ,, ,, 2,688 ,,
No. 3 ,, ,, 3,360 ,,
No. 4 ,, ,, 2,464 ,,
(Each piece measured 30 x 2 x 2 inches.)

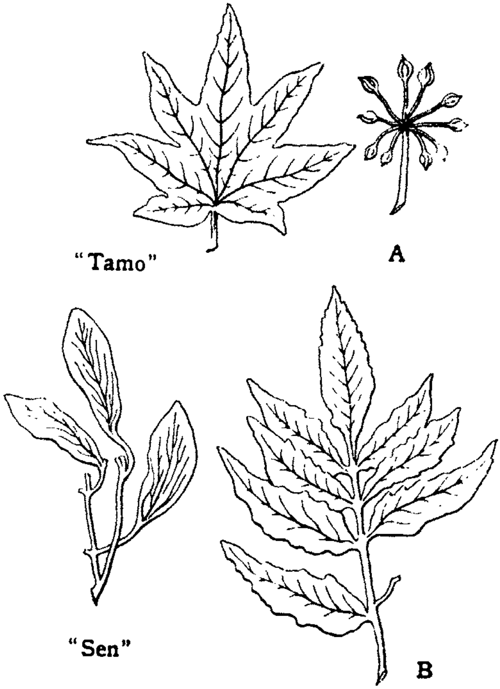
The character of the break in Nos. 1 and 3 was very satisfactory, and showed long and tough fibre. Nos. 2 and 4 were only fair. Several tests for bending strains have been made, giving excellent results, the most difficult and trying turns and strains being accomplished satisfactorily. There is no doubt that, except for bent work, where very white wood is demanded, and which is a condition which Japanese ash cannot fulfil, this timber would satisfy all requirements. Sargent concludes his article in the *Forest Flora of Japan* as follows: "Here are great supplies of oak and ash of the best quality . . . a storehouse of forest wealth, which, if properly managed, could be drawn upon for all time." These remarks are of singular importance now (1919) when we consider the gigantic demands which have been made upon our own home-grown supplies of ash in only the three years of 1916, 1917, and 1918, and, limited to the knowledge we now possess, it should be considered almost criminal to use any of our own home-grown supplies of ash for any kind of purpose for which such a timber as the Japanese variety could be substituted. The trees are the product of a perfectly natural virgin growth, under the best conditions, and yield clean, straight boles of considerable length and diameter, from which a large amount of sound straight-grained boards and planks clear from knots can be obtained. This quality makes Japanese ash most useful for a great variety of purposes. It has been utilised for cabinet and pianoforte work, both solid and as a groundwork for veneer. The wood takes the glue admirably, and the veneers laid retain a hard, flat surface. For constructional work, excepting where considerable strength is needed, it can be used advantageously, and its comparative lightness of weight increases its value. This same quality, added to the fact that it possesses the requisite strength, makes it an ideal timber for automobile construction, both for carriage body work and for delivery vans and lorries. In many places in Scotland and elsewhere, it has been used for house and club decorative joinery, and furniture. When finished in its own natural light colour, or stained like dark oak, it has produced some very artistic and decorative results. For ships' fittings, cabins, etc., and furniture, it is especially suitable. Without a very rigid selection, reliable stretcher-poles have been provided. A small quantity has been found strong enough for aeroplane construction, and if more care is taken a considerable supply could undoubtedly be found suitable for this work. At least one aeronautical pilot has selected the wood for use. In Japan it has been largely used for house-building, sleepers, oars (both for the navy and for ordinary use), clogs, and all kinds of wooden ware. It is beyond question that the demand for ply-wood in the future will be almost unlimited, and as Japanese ash is very suitable for veneers, probably the whole available supply from Japan could be used for this purpose alone.

The disadvantages of the wood consist in its colour (though that is chiefly because of the rather prejudiced preference for ash which is white in appearance), its liability to brown streaks, which follow the lines of the concentric layers, and its somewhat porous nature.

A considerable quantity of hewn pieces and roots containing twisted, curly, and fiddled mottle grain were imported into France, Germany, Belgium, and the United Kingdom for veneers before the war, and these were well received. This popularity will probably revive in the future expansion of trade. A considerable number of sleepers have been imported, which, although they are accepted and used largely in Japan, have not found favour in this country. According to Baterden, such use has been made of the wood on the Chinese and Manchurian railways.

The concentric layers are very clearly defined. The pores are open and numerous in the spring growth, but exceedingly small in the autumn growth. The medullary rays are very small, fine, clear, and parallel.

In the accompanying drawing, the figure A represents the leaf and fruit of ash (*Fraxinus mandschurica*), the Japanese "Tamo," and B is "Sen" (*Acanthopanax ricinifolium*).



ASPEN. *Populus tremula*, Linn. Europe.

The colour of the wood is a light yellowish-grey; it is exceedingly tough and close-grained and somewhat resembles alder. It is a beautiful wood, but is very apt to warp and twist. Its most important use is for match-making, for which purpose it is very valuable.

A report appeared in the *Timber Trades Journal* of October 5, 1918, as follows:

"At Bitterne, on the banks of the River Itchen, in clearing the ground for extensions to H. J. Beazley's shipyard and engineering works, an aspen tree was recently cut down. The trunk was over 35 feet high, its girth 13½ feet, and when uprooted the base of it measured over 27 feet round, the tree appearing to be about a century old. It is interesting to note that around the roots were found numerous fragments of Roman pottery and a considerable number of other relics of the Roman occupation, and some coins, including one of the period of Constantine I. in an absolutely perfect condition. Bitterne Manor marks the site of the local walled Roman city of Clansentum [*sic*] (Clausentium), the greater part of which site is now occupied by the timber-yard and wharf of W. W. Howard Bros."

Although I have been on this site on many occasions I regret I never observed the tree until it was cut down. When this was done I secured a specimen for examination. The concentric layers are very indistinct and confused, and it is impossible to count the rings or gain any knowledge of the life of the tree. The timber is of a pale yellow-grey colour, with a close, tough texture, and, although not so hard, is rather more like maple than like any ordinary poplar. In seasoning the wood has warped somewhat, and would appear liable to this defect.

BANKSIA. *Banksia littoralis*, R. Br. Weight, 43¾ lbs. (Stone). Western Australia.

This wood, which is also called " River Banksia," resembles in colour, grain, and general character the cigar-box cedar (*Cedrela odorata*), without, however, possessing its aromatic scent. It seasons well and stands under all conditions without warping, twisting, or splitting. It was lately recommended as a suitable wood for aeroplane propeller blades. There is rather a scanty supply, and a difficulty in getting it, as it grows very sparsely over a wide extent of country. It is often well figured and is suitable for furniture and decorative work.

BARBERRY. *Berberis vulgaris*, Linn. North America.

The name barberry, or more correctly " bearberry wood," is given to the wood of Canadian buckthorn (*Rhamnus purshiana*) and possibly to common buckthorn (*R. cathartica*). The former is described by Anderson (quoted by Stone) as " used for ornamental purposes . . . one foot in diameter or slightly smaller." The barberry wood of commerce may be any of these, or it may be the produce of *Bumelia lanuginosa*. Generally the wood is of small size, not exceeding 4 inches in diameter. The heart-wood is streaky, of dark and light colour. The sap-wood is a bright yellow when fresh, and retains this colour for many years when screened from the light (as, for instance, in Nördlinger's wood-sections). The wood is hard and dense in texture, and is used in turnery and marquetry.

The annual rings and medullary rays are well marked, and there is a distinct porous spring-zone.

BARWOOD. *Pterocarpus santalinoides*, L'Hérit., or *P. angolensis*, DC. Weight, 54 lbs. West Africa.

The wood is of a bright and vivid red colour, it has a close, firm texture, and is capable of a very smooth surface from the tool. It is imported in short, round logs ranging from 4 to 12 inches in diameter. It is used for the handles of tools and cutlery and would be suitable for turnery. Barwood is also used as a dyewood, and if water is poured on it, the red colouring comes out.

The large pores are very unevenly scattered. The light wavy concentric lines are very noticeable, but no medullary rays are visible.

BASSWOOD. *Tilia americana*, Linn., *T. heterophylla*, Vent., and *T. pubescens*, Ait. Weight, 30 lbs. North America.

True basswood is the wood of several North American species of lime-tree. The name is often, though erroneously, employed in England and Scotland to designate the wood of *Liriodendron tulipifera*, which is most commonly known under the name of whitewood or canary wood in this country, and yellow poplar or poplar in America. The consequence is that misunderstandings are liable to arise on the rare occasions on which genuine basswood is ordered from the timber merchant, for the latter assumes that whitewood is wanted. Small quantities are imported into Liverpool and London in the form of logs, and in boards and planks from 10 to 16 feet in length and from 4 to 24 inches in width. The wood imported varies both in tint, which ranges from white to light or greyish brown, and also in quality, this possibly to some extent because it consists of the product of several different species of lime-tree, but also certainly according to the time and manner of felling and storing the produce of the tree. The wood is soft, light in weight, and by no means strong. " Its lightness makes it serviceable as valves and other parts of bellows for . . . organs (mechanical) and piano-players. . . . Apiarists find no wood more suitable for the small light frames in which bees build the comb. . . . Its whiteness and freedom from stains and unpleasant odours are likewise important when vessels are to contain food-products." (Gibson, *American Forest Trees*, p. 638.) Indeed, Longfellow mentions the wood in this connection, for at the wedding feast of Hiawatha :

All the bowls were made of basswood,
White and polished very smoothly.

In the United States the wood is largely employed, especially in the pianoforte trade, and its uses are very varied, but in England, although it is inquired for in the same trade to a limited extent, there are other woods available that are equally serviceable yet procurable at lower prices, and which, therefore, have the precedence. For joiners' work it is not so serviceable as whitewood as it is liable to warp. It is not more useful for most purposes than tupelo gum, which is less costly. When pure white it is most valuable, but in this condition it is exceedingly difficult to obtain.

The annual rings are recognisable though not sharply marked. The pores are small and scattered. The medullary rays are just visible to the naked eye in cross-section.

Bauhinia retusa, Ham. Weight, 58 lbs. (Troup). India, Burma.

A log of this wood was sent over to the Imperial College of Science and Technology, South Kensington, in 1914. The wood is of a dull, rather dirty brown colour, with almost black streaks which, however, develop gum cracks and other defects, giving altogether a rather unusual appearance, on account of which it would be useful for inlay work for cabinets. Gamble says: " The wood is the best of those of the Bauhinias, but is not much used. . . . [The] wood [is] red, with irregular dark red or black patches and streaks near the centre, hard; having pale bands of soft tissue, which alternate with dark bands of firmer texture."

The pores are very variable in both size and position, and the medullary rays are exceedingly fine and regular.

BAYWOOD.

In the United Kingdom " baywood " is still sometimes specified in contracts and demanded. What is required is a plain, straight-grained, mild mahogany. The name seems to have arisen in the following manner. When mahogany was first introduced to Europe it was brought from islands in the West Indies that were owned by Spain: it was therefore termed " Spanish mahogany." Subsequently there was discovered in the Bay of Honduras a valuable wood, milder, softer, and straighter in the grain, than the other mahogany: this wood was therefore termed " baywood," and was identical with Honduras mahogany.

BEDARU. *Urandra* (*Lasianthera*) sp.[1] Weight, 58 lbs. 6 oz. Borneo, the Malay Peninsula.

This wood has not yet been imported into England in commercial quantities. It is of a light yellow colour, somewhat resembling satinwood, shows broken streaks of dark and light colour, and is mottled and speckled. It is dense, heavy, and of close texture. It should serve as a useful furniture wood. Foxworthy mentions its use for piling.

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[1] There appears to be some doubt as to the origin of bedaru, as it has also been referred to another genus, *Apodytes*, belonging to the same family (*Icacinaceae*), also to *Sideroxylon malaccense* in the Malay Peninsula; the authority for its reference to the genus *Urandra*, as far as Borneo is concerned, is F. W. Foxworthy in *The Philippine Journal of Science*, vol. iv. p. 542.

In cross-section concentric zones are marked here and there. The scattered pores are invisible, though their arrangement is marked by a white halo round each: under the lens they are seen to be plugged. The numerous medullary rays, though fine, are just visible.

BEECH, EUROPEAN. *Fagus sylvatica*, Linn. Weight, 43 lbs.

The common beech tree is widely distributed over Europe, extending from Great Britain and Norway to Spain; it is also found in Asia Minor, and occurs even in Japan.

The wood is light reddish-brown, moderately hard and heavy, close and even in texture, with a fine silky grain. The trees after being felled should be sawn into planks, boards, and scantlings as soon as possible. If conversion be delayed, incipient decay is soon indicated by the appearance of white specks or brownish or pink streaks. The wood is lacking in durability when exposed to alternate dryness or wetness, so that it is unsuited for outdoor constructional work, or for props or railway-sleepers; moreover it is sensitive to changes in moisture, for it readily warps and cracks. Yet when felled and at once placed under water, beech is very durable. In partial illustration of this statement may be mentioned the beech logs that formed the original foundation of Winchester Cathedral. These were laid in 1262 in successive layers in peat [1] and water to a depth of from 5 to 15 feet. In 1906 Messrs. J. Thompson & Co. (of Peterborough) raised these water-covered logs, which were found on the outside to be soft and spongy to a depth of many inches, but at the core to be hard and sound, varying in colour from light brown to dead black. In the dry air of rooms, beech in the form of furniture lasts indefinitely as far as resistance to decay is concerned, but here it is very liable to attack by "worm" [beetle], which sooner or later will excavate and with its fine tunnels destroy the wood. Many costly chairs of the Queen Anne period were made of beech, stained and inlaid in beautiful English and Dutch marquetry work. The framework of some of these is often found to be riddled with the "shot holes" of the "worm," which has thus caused the destruction of the furniture. A valuable violoncello has been lately spoilt owing to the appearance of these "worm" holes, which have perforated the sides and back, in which, unfortunately, beech wood had been used. These beetles also continually spread to other furniture, of whatever wood it may be. If, therefore, any article is to last for any considerable length of time, beech should not be used in its construction.

Despite these limitations beech wood is valuable, and is employed for many and very varied purposes, since it is strong, elastic, splits well, takes a good polish, and, when steamed, is readily bent. It is used for tools, planes, keys and cogs of machinery, shoe-lasts, boot-trees, toys, malt shovels, brushes, and saddle-trees. Another important use is in the making of wrest-planks for pianos, and of the English beech used for this purpose, it has been said that that which is grown in Devonshire or Essex far excels any other. In welding or fusing glass it is used almost exclusively. According to Messrs. J. Powell & Sons, beech-wood billets are used for supplying great local heat whilst large glass objects are being fashioned. All other wood, except beech, produces a white film (sulphur) on lead-potash glass, which is only removed with some difficulty. In this connection some sycamore billets used by mistake caused considerable trouble.

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[1] Probably the peat aided in the preservation of the logs.

One of the chief uses of beech is in chair-making. In addition to the manufacture which is carried on in factories, the industry is also plied in the woods of Buckinghamshire and other districts of England. Here the felled trees are sawn through, cleft, and turned into legs and rails for chairs in the same manner, and by the same primitive kind of pole-lathe, as has been in use for centuries. Beech is extensively employed in the brush industry. Its cohesive qualities, associated with a moderate degree of softness, enable this wood to withstand the strain of the close boring without splitting, as do some stronger and harder woods. It also resists the combined action of soap and water to a greater extent than do most timbers.

In Hungary for the brush trade the trees are cut into lengths of from 6 to 8 feet; the resultant drums are then cleft into four quarters, which are set out to dry, and are finally sawn into the necessary sizes. This method of cleavage is wasteful, but yields exceedingly bright, good-coloured timber. In that country the wood is also used for the manufacture of complete suites of furniture for domestic rooms and offices.

Beech is an excellent firewood, and is largely used for this purpose in France. It is also admirably adapted for the production of acetic acid (and acetone) by its destructive distillation.

There seems no reason why English beech should not make very good wood-pavement and flooring, if properly creosoted and carefully laid. Indeed for the former purpose it has already been used with fairly satisfactory results. It possesses the necessary tough, spongy quality, and does not become slippery as do some other hardwoods. Its expansion and contraction is also less. An experiment with a block 7½ inches long 3 11/16 inches deep by 3 inches wide showed, after being soaked in water for fifteen hours, no change whatever on the two smaller measurements of the block, and only a bare ⅛ inch increase on the wide. Similarly in a smaller size, a piece thoroughly dried, 6 1/16 inches long by 4⅛ inches wide by ⅝ inch thick, showed 6⅛ inches long by 4 3/16 inches wide by 11/16 inch thick.

The concentric layers are very strongly marked, the pores are small and obscure; the medullary rays, which are sharply marked, are very numerous and vary greatly in strength and size. They are very pronounced on the radial section.

BEECH, JAPANESE. *Fagus sylvatica*, Linn., var. *Sieboldi*, Maxim. Weight, 26 lbs. Japan.

"Beech in Japan is used for making boats, ploughs, handles of tools, rifle-stocks, clogs, spinning-wheels, lacquer ware, and various utensils. . . . Oil from the seeds is used for lighting as well as for food . . . treated with preservatives it is especially suitable for sleepers and foundations." (Goto.) The wood is very similar to that grown in England, but it is of a more uniform colour, a light yellow brown, not white, and is rather softer and milder, and keeps its shape very well indeed. Although the wood is very soft, the growth is slow and regular.

The annual layers are very narrow and uniform. The pores are very small and indistinct, and the medullary rays strong and prominent.

BEECH, TASMANIAN, or EVERGREEN BEECH. *Fagus Cunninghamii*, Hook. Weight, 47 lbs. (Baterden). Tasmania.

Tasmanian Timbers gives the following account of this timber: "The wood varies from a greyish-brown to a brown-pink; when planed it takes a beautiful surface, and, like the European beech, always wears smooth. It is a strong, close-grained timber, and, except for the colour, resembles European beech, but is of considerably greater average strength. If cut from a level of 800 feet above sea-level, and felled in the winter, it is a very durable wood for outside work, but it is apt to 'go' between wind and water. It makes splendid felloes, staves, saddle-trees, gun-stocks, and all kinds of turnery, floors, skirtings, and dados. The pinker tints make handsome furniture. The seasoning and treatment of this timber should be exactly that of European beech, and it must be felled in the winter to get the best results. Although there are such large quantities of *Cunninghamii* in the Island very little of it has been exported hitherto. The difference between the grey and the pink is hard to account for, as they are botanically identical, and there is no apparent reason for the difference."

BEEFWOOD. *Mimusops globosa*, Gaert. Weight, 59 lbs. 11 oz. British and Dutch Guiana.

This [1] wood is imported in the form of square hewn logs ranging from 15 to 40 feet in length, and from 10 to 18 inches square. That from Surinam (Dutch Guiana) is of the better quality, the Demerara (British

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[1] Other names of this wood, including "bulletre" (Bulétre) and "bully-tree," are doubtless perversions of the native name "balata," and lead to yet another name, "bullet-wood."

Guiana) timber being rather knotty. In the log on calliper measure it averages about 30 to 32 cubic feet to the ton.

The wood is a dull plum-red colour, and in this respect it somewhat resembles raw beef. With the plane it yields a very smooth surface, upon which glisten the minute shining specks of substance contained in the pores. Stone and Freeman give the following account of its other qualities: "Very durable, stands exposure, suffers from teredo and worms, . . . fissile, takes nails badly." In England it is only in occasional demand, and is used in the manufacture of the best umbrella sticks, which, even when thin, are very strong. On the Continent, however, where there is a constant demand, beefwood (of this and possibly other kinds) is used largely for making violin-bows of a second-class quality, walking-sticks, rollers, and tools.

The cross-section is marked by concentric layers of various widths (which may represent annual rings) visible to the naked eye, also by numerous light-coloured concentric lines which, like the similar but finer invisible medullary rays, are almost or quite invisible to the naked eye. The small numerous pores are individually invisible, but are linked in small radial lines by light-coloured tissue, and these light radial groups are visible to the naked eye. The pores have contents that are light yellow or orange in my specimen, which in structure and appearance accords with the description given by Stone and Freeman, except that these authors describe the contents of the pores as red. This may be a casual variation, or may denote that mine is a different species of *Mimusops*.

Beefwood is very similar to messaranduba (*Leucuma procera*) (*q.v.*)

Under the name of beefwood another timber may be encountered, that of *Swartzia tomentosa*, DC., which appears (judging from Stone and Freeman's description) to differ *inter alia* by the tiered structure shown in the tangential section, as well as by the scattered pores.

BENTEAK. ***Lagerstroemia lanceolata***, Wall., syn. *L. microcarpa*, Wight. Weight, 53 lbs. West Coast of India.

The wood is of a warm brown colour similar to that of black walnut (*Juglans nigra*), and has a smooth, close texture and straight grain. It would be much sought for and command a high price if regular supplies were forthcoming. This should be possible, as Gamble says that large sizes in length and squares are obtainable. It is highly suitable for decorative furniture and fittings, and could be used where black walnut is in request.

The pores are numerous and irregular in size and position, largely plugged with shining gum. The medullary rays are very fine and scarcely perceptible even with the lens.

BETIS. *Illipe betis*, Blanco. Weight, 56 lbs. The Philippines.

Foxworthy describes this as "a very hard, heavy, durable wood; used for piling, ship and boat building, . . . keels of boats, . . . railway ties and sleepers, . . . posts of houses."

BIG TREE. *Sequoia gigantea*, Decaisne. Weight, 24 lbs. North America.

While this tree is indigenous to North America, it has been very successfully cultivated in England, where, however, it is known as Wellingtonia. It should not be confused, as it often is, with the sequoia or redwood of America.

The wood is light, soft, and spongy. It varies in colour from pale yellow to a warm red, with a very broad white sap edge. The concentric layers are usually wide. The wood is generally of little value, as it is brittle and possesses little strength. It is, however, said to be durable in contact with the ground.

BILLIAN. *Eusideroxylon Zwageri*, T. and B. Weight, 70 lbs. (Baterden). Borneo, Malay Peninsula.

This timber varies in colour from dark to light brown when first cut, while it deepens almost to black on exposure to light and air. It is one of the hardest and heaviest of the Borneo and Malay woods. It has occasionally been imported, and has been inquired for from time to time in the United Kingdom for some works of importance. Foxworthy mentions its use in heavy construction, bridges, and telegraph and telephone poles, and railway ties and sleepers, and says that it is perhaps the best wood in the world for piling. He adds, "Billian is one of the very few woods of Borneo which is known outside this region. It is exported to Europe in some quantity and has been used for piling at several places in Holland and France. It is deserving of wider use, but a few years vigorous exploiting will exhaust the available supply of it."

BIRCH. *Betula alba*, Linn.; *B. lenta*, Linn., etc. Weight, 47 lbs. 13 oz. Europe, North America.

The wood is of a yellowish-red colour, and is very tough and fairly hard, close in texture, and easy to work. It is imported into this country in logs varying from 6 to 20 feet long and 12 to 30 inches wide, and in sawn square-edged planks and boards mostly from 10 to 16 feet long and 4 to 18 or 20 inches wide. For many years it was used extensively for furniture of all kinds, but of late, except for inexpensive chairs, it has largely gone out of fashion. It is, however, in great demand for automobile carriage building, for step-boards and frame-work, carts and vans, desks and office furniture, agricultural implements (Spenser in the *Faerie Queen* speaks of "the birch for shafts"), and general woodwork. Some of the wood is beautifully figured with wavy, curly grain, and when stained and well polished is a good substitute for mahogany. In America it is employed in this manner for doors and general trimming for hotels and other buildings. In that country it is also used for floors, for which it is admirably adapted. It is remarkable that it is not used for this purpose in the United Kingdom, as it makes a very fine flooring, both as regards appearance and durability. In America, ply-work has of late years consumed large quantities. Other varieties of birch are also used in the same manner both in this country and in America. Amongst these Holtzapffel mentions the following: "*Betula excelsa*, also called yellow birch, has wood much like *Betula lenta*, and *B. nigra* is also much esteemed. *B. papyracea*, paper or canoe birch, is employed by the North American Indians in constructing their portable canoes. *B. bhojputtra* is a Himalayan species of which the bark is used for writing upon, and for making the snakes of hookahs."

"The bark of the paper birch, and, to a less extent, that of other species, is as important to the inhabitants of Canada as that of the common birch is to those of Northern Europe. Canoes and lodges are covered with large sheets of bark; it is placed on shingled roofs under the shingles, to prevent the water from coming through; and very ornamental boxes, baskets, and other articles are made from it by the Indians. It also serves as a writing material, and I have a clearly written letter from Professor Elrod, sent me by him when, making an expedition in Montana, he ran out of paper. (Elwes and Henry, *Trees of Great Britain and Ireland*, p. 994.)

There is little doubt that the birch planks and boards from America are the produce of all the different varieties mixed indiscriminately, and it may also be the case with the Canadian, as it is doubtful if even experts can certainly discriminate between the wood of the different sorts.

British and Continental grown trees are much smaller than Canadian, American, and Japanese. Most of the former is much lighter in colour, though Holtzapffel says that the Russian wood is of a full yellow colour. Three-ply and other veneer in which this bright-coloured wood has been used has lately been imported. A considerable quantity of birch is received from Sweden and Norway in small sizes and sawn squares for various trades. Perhaps the largest demand is for short pieces, about 3 inches square and 6 feet long, which are used for placing in the brickwork of buildings to support the scaffolding. These are called putlogs and are mostly imported from Cristiansund. All sizes are employed for brush-making, and a moderate supply for staves and box-boards is greatly in demand.

Holtzapffel notes that the wood is not very durable, and adds, "the bark of the birch tree is remarkable for being harder and more durable than the wood itself; amongst the northern nations it is used for tiles of roofs, for shoes, hats, etc. The Russians employ the tan of one of the birch trees to impart the scent to Russia leather, which is thereby rendered remarkably durable. The inner bark is used for making the Russia mats."

During the European war, as the shipments of foreign supplies largely ceased, a considerable quantity of British birch was used, especially in the brush trade. On the whole it was found to be quite useful, although it was reported as being not quite so good as the Norwegian wood.

The pores are exceedingly small, somewhat plugged. The medullary rays are fine, close, and parallel; the wood shows dense, close, compact growth.

With the American wood the pores are larger and more open. The medullary rays are well defined, parallel, and joined at irregular intervals at right angles by deeper-lined veins.

The pores and rays of the Canadian wood are similar in all respects to the American, but the general character of the growth is more dense and compact.

BIRCH, JAPANESE. *Betula Maximowiczei, B. ulmifolia, B. alba,* Linn., var. *vulgaris,* DC. Weight, 48 lbs.

During the last few years some considerable quantity of hewn square logs from about 8 to 20 feet long and 12 to 36 inches broad have been imported from Japan. It is there termed Shira-kamba (*Betula alba*). The logs are clean and very sound, with straight hearts, and are of better quality than any of the Canadian or American wood. The colour is a bright yellowish-red, and the wood is slightly harder, tougher, and more closely grained than is the Canadian. I consider it superior to all the other kinds in commercial use for all purposes for which birch is used, but it is doubtful if it can be brought here at such a price that it will compete with the Canadian. Recently some well-made three-ply veneer faced with Japanese birch has been imported, and should prove useful for many purposes.

The pores are smaller than in the Canadian wood, and are almost entirely plugged. The medullary rays are fine but distinct, and are joined at right angles by a thin vein which occurs at close intervals.

BISCHOFIA. *Bischofia javanica,* Blume. Weight, 45 lbs. (Gamble). Formosa, India, Burma.

This wood is of a dull reddish-brown colour, of close, firm texture, while in appearance it closely resembles American black walnut, though slightly redder. Much of it displays wavy grain. It stands well, but is apt to be riddled with small holes due to the attacks of a kind of boring beetle. The wood has not yet been commercially imported into England.

The pores are small and evenly distributed. The medullary rays are numerous, fine, parallel, and equidistant.

BLACKBEAN. *Castanospermum australe*, Cunn. Weight, 40 lbs. (Baterden). New South Wales, Queensland.

The merits of this timber are well known in Australia, but it was comparatively unknown in England until utilised in an exhibition at the White City, where a room was completely furnished and panelled with it. Blackbean has an attractive appearance, showing various shades of brown traversed with black streaks, and is often handsomely mottled, so that it resembles slightly bleached East Indian walnut (*Albizzia Lebbek*). It is close in texture and with the plane yields a fine surface that looks very well when polished; it is also well adapted for carving.

Blackbean is used for the panelling and general woodwork of the library at Australia House, London. The wood gives a most handsome and effective appearance to the richly decorated and carved work, which was carried out by Messrs. Wylie & Lochhead at a cost of £7000. The panelling in the High Commissioner's room is also of this wood.

The pores are visible, rather large, moderately numerous, and plugged with microscopic cists (thyloses). They are scattered and are either found solitary or grouped in minute radial series, up to five pores in number. They are surrounded by an almost white tissue, which extends and tapers in a tangential direction and may link on to the next mass, thus giving rise to concentric light lines. The excessively fine and numerous rays are invisible to the naked eye.

BLACKBUTT. *Eucalyptus pilularis*, Sm., *E. patens*, Benth. Weight, 57 lbs. 5 oz. Western Australia.

This is a close-grained, hard wood of a dull brown colour. In common with all the other Eucalyptus species, it shows a marked inequality of the hard and soft grain in seasoning; it also warps and twists and is inclined to crack. It has been used in London for wood pavements, but not with very satisfactory results. It expands and contracts continually, and for this reason it often causes trouble. It is tough and durable, and, in common with other Australian timbers, and particularly the Eucalypts, it has strong fire-resisting qualities.

Blackbutt is a very useful timber for railway waggon building, and for this large quantities have been used in place of oak, and the results were fairly satisfactory.

The pores are numerous and in groups; they are partly plugged. The medullary rays are extremely fine and irregular.

Blackwood, African. *Dalbergia Melanoxylon*, Guill. and Perr. Weight, 89 lbs. 4 oz. Tropical Africa.

This timber is also called black Botany-Bay wood, although this name is now somewhat out of date. It is a dark purple plum-coloured wood, now imported from Mozambique and the east coast of Africa; for this reason it is also known as Mozambique ebony. Mr. A. E. Gardner says it was formerly known as Ébène du Portugal, and that it is quite a different growth from the ebony of the west coast or the Madagascar ebony. It is probably the same timber reported by Holtzapffel as being of doubtful origin, but that certainly some had been imported from the Mauritius or the Isle of France. He adds, " it is probable that this wood, in common with many others, may have several localities. . . . It is most admirably suited to excentric turning, as the wood is particularly hard, close, and free from pores, but not destructive to the tools, from which, when they are in proper condition, it receives a brilliant polish. It is also considered to be particularly free from any matter that will cause rust, on which account it is greatly esteemed for the handles of surgeons' instruments."

These characteristics should recommend this wood to the attention of those who are looking for a high-class, reliable substitute for ivory and other articles, now very much more costly, which have been used for the handles of knives and tools. The chief use of African blackwood, however, is for the making of musical instruments. It is imported in billets, from 5 to 10 inches in diameter, of irregular growth and shape, and of a faulty description.

The pores and the medullary rays are equally indistinguishable with the lens.

The Bombay blackwood, otherwise known as rosewood (*q.v.*) and well known in the timber trade, is the product of *Dalbergia latifolia*, Roxb.

Blackwood, Australian. *Acacia Melanoxylon*, R. Br. Weight, 48 and 57 lbs. (other specimens stated to be as low as 36 lbs.). Australia (including Tasmania).

In colour the wood varies from rich reddish-brown to nearly black, banded with golden brown; sometimes it is brown and red with dark streaks, and may show metallic lustre. Its grain is close, often curly, and it appears to be somewhat cross-grained, so that the wood often shows pretty figure and mottle. It is easily worked and is susceptible of a fine polish, but must be thoroughly seasoned. Mr. Baker (in his work *The Cabinet Woods of Australia*) states that blackwood should perhaps be placed second only to *Cedrela Toona* as an Australian cabinet timber. As a handsome decorative wood it has been used for fittings in banks, railway-cars, passenger steamers; and a mantelpiece made of this wood was exhibited some years ago in the Colonial Exhibition at

Earl's Court. It has been successfully used to make gun-stocks. It is, moreover, a strong timber, and Mr. C. Lyne (Minister of Lands and Works) wrote in 1903: "Orders are now being supplied to the Admiralty for use in the construction of gun-carriages in the arsenals, where it has been tested and given satisfaction." It is not well known, and has not been much used in the United Kingdom, where it might with advantage be employed in decorative and cabinet work.

The wood in cross-section shows alternating darker and lighter concentric bands, which may denote the presence of annual rings; the pores themselves are invisible (though clear enough in side-view), but their positions and scattered arrangement are revealed by reason of the light haloes surrounding each tiny group; the medullary rays are invisible and so fine as to be only just recognisable with the magnifying glass (12 ×).

Boehmeria rugulosa, Wedd. Weight, 41 lbs. India.

This timber is unknown in commerce though possessing remarkable qualities: it probably surpasses all other woods for carved work. The colour is a light salmon-red darkening on exposure to the air to a dull red mahogany shade. The sap-wood is an unsightly dirty brown. The trees are liable to the attack of small worms or beetles, and also to a grub which leaves a larger hole. The wood works easily, and the grain is straight and takes a very smooth surface from the tool. Troup says it is "apparently not to be obtained in large size . . . not common in India, being found scattered in the Forests." Gamble mentions that it is used for making bowls, cups, plates, and all kinds of domestic utensils . . . for which its character of being easily cut and carved without splitting or warping, well adapts it." The Rajah of Nepaul presented a marvellous piece of native carved work in this wood to Mr. H. J. Elwes on his last visit to India. It would be greatly esteemed by the artist craftsman for fine work if it became known and supplies were available.

The concentric layers are clearly marked. The pores are scattered irregularly between the rays, mostly plugged with shining specks of solid substance. The numerous medullary rays are thick, parallel, but not regular.

Bombax insigne, Wall. Weight, 31 lbs. Andaman Islands, India, Burma.

Like the well-known cotton tree, *Bombax malabaricum*, this yellowish-white, soft, perishable, and non-durable timber is not likely to find much use in Europe. It is used in India for cheap work such as planking and packing-cases. In structure it is similar to *B. malabaricum*, except that the pores are smaller and less scanty.

Boxwood. Sources various.

Ordinary genuine boxwood is derived from the evergreen shrub or tree *Buxus sempervirens*, Linn., which is familiar as a shrub in English gardens, but also occurs in sunny places in this country as a wild plant. Extending over a large part of Europe from Norway to the Mediterranean, thence across Asia as far as Japan and the Himalayas in India, it is mainly a shrub in the northern situations, but attains a tree form in countries bordering the Mediterranean and the Black Sea, the Himalayas and, remarkable to mention, in England at Box Hill in Surrey and other places. While the commercial wood is of all the following kinds, British, Mediterranean, Turkish, Abasian, Persian, and Himalayan, yet the main supplies come from the countries bordering on the Black Sea. All these woods will be described under the general heading of European and Asiatic boxwood. How considerable has been the trade in Caucasian and Persian boxwood is seen from the quantities exported to England, France, and Turkey, which are reported in *Trees of Great Britain and Ireland* (Elwes and Henry). From the Caucasus between 1883 and 1887 there was a yearly average of 2340 tons, and from Persia in 1906, 1560 tons. Since 1890 the Caucasian trade has diminished, and in 1895 the total export had fallen to 1200 tons.

In addition to these European and Asiatic varieties genuine boxwood of another kind, the product of *Buxus Macowani*, comes from south-west Africa and is known as African or East London boxwood. This name is also given to the dangerously poisonous wood of another South African tree, *Gonioma Kamassi*, E. Mey, also known as Knysna boxwood and Kamassi wood. These will be described under the heading of African boxwood, which also includes a third kind. Other so-called boxwoods, which are not products of *Buxus* and lack some of the qualities of true boxwood, are the West African, West Indian, Ceylon, and Australian boxwoods. Of these the West Indian is the only variety which has yet occupied any important place in commercial usage.

The wood is light yellow, very hard and heavy, of dense, most uniform texture and very fine grain. This unique homogeneous wood has, when fully seasoned, the further valuable property of resisting splitting, and of yielding a fine surface when turned or planed. It has, therefore, special uses in the manufacture of wood-engraving blocks, rulers, mathematical instruments, handles of tools, planes, shuttles, wood wind instruments, combs, and inlay work. During the European war, although many other descriptions of wood were tried, boxwood alone was found capable of resisting the great strain of hammering the load into shells, and was so used in the form of what are termed "punners" or "stemming rods." These are circular rods 1¼ inches in diameter, and varying in length from 14 inches to about 3 feet. The rod is struck by hand with a mallet with considerable force. Of the different varieties used the British and African (*Buxus Macowani*) have proved to be the strongest. The West Indian has given fairly satisfactory results, but although less wasteful in conversion, has not proved so strong.

In some cases the trees exhibit loose growth, and the wood in drying splits spirally. Exposed to damp, it is very liable to deteriorate, undergoing discoloration and a form of decay. During seasoning it is very apt to split. For this reason large logs are sometimes quartered, or the square log is cut down the middle of its four faces. In France, according to Beauverie (*Les Bois industruelles*; Paris, 1910), special precautions are taken to prevent splitting, the wood being either stored during seasoning in a dark room or cellar until ready for use, or immersed for twenty-four hours in cold water, in which it is afterwards boiled for some time. It is then wiped and dried and protected from light and air by being kept in sand or bran.

About a hundred years ago, the workmen in Scottish factories where shuttles were made, kept the wood stored for two years in dry pits slightly below the level of the ground, and covered with dry straw or hay. When they were ready to use it, it was steamed for about twenty-four hours in a steam chest and was then roughed out to what was approximately the size required, after which it was found to stand perfectly.

The result of these natural deficiencies is that the trade in boxwood is very speculative. For instance, before the war, if a block of boxwood was split it would sink in value from £60 to £4 per ton.

Abasian boxwood for wood engraving purposes for the best work is perhaps the sole kind for which a satisfactory substitute cannot be found. Formerly pieces of boxwood found unsuitable for engraving were utilised in the manufacture of various articles, including shuttles, but the introduction from the United States of persimmon and cornel wood, which are adequate substitutes in the weaving trade, has caused a heavy decline in the demand for Abasian and Persian wood. The sawdust is used for cleaning jewellery, and is much in request since the war, realising as much as £9 and more per ton.

The transverse grain reveals with the aid of the lens very little structure. The tree grows very slowly, so that the annual rings are narrow and more or less inclined to be sinuous, and though recognisable to the naked eye, are not very sharply marked. The medullary rays are so fine as to be only just visible; sometimes, indeed, they are invisible to the naked eye in transverse section. The pores are so minute that even with a lens the wood might be mistaken by a novice for a very hard, coniferous wood.

BOXWOOD, AFRICAN. *Buxus Macowani*, Oliv. Weight, 54 lbs. 11 oz. South Africa.

An alternative name which is sometimes used, is East London boxwood.

The colour is a bright yellow, very similar to the Turkish variety, but a little brighter, and with a slight tendency to be flecked with small black marks. The wood is firm, dense, hard, and very strong, and compares favourably with the Turkish. It is imported in logs ranging from 3 to 20 feet in length and 1½ to 9 inches in diameter, with a few larger pieces. The timber is available in apparently unlimited quantities. It is slightly more wasteful in conversion than the other kinds, as it develops small faulty places, knots, and wens. It stands well and is not so liable to split in the log as either the Persian or West Indian wood. It is desirable, however, that the same care should be taken with its storage as is necessary with other kinds of boxwoods.

The structure of the wood most resembles that of the British, with which it compares favourably. The medullary rays are slightly less noticeable and numerous.

BOXWOOD, EUROPEAN. *Buxus sempervirens*, Linn.

(1) BRITISH. Weight, 70 lbs.—This can be obtained in diameters from 1 inch to about 4 inches, with a few larger pieces which measure perhaps up to about 7 inches. The intrinsic quality of the wood compares favourably with the best known Abasian, and it seems probable that its present unfavourable reputation is largely due to want of care in the manner in which it is harvested. It is important that it should only be cut down during the month of January. Immediately after the felling of the trees the wood should be placed in a dry pit a little below the level of the ground, and covered with dry straw. If possible it should remain in this position for two years before use. It should then be removed only as required, and in no circumstances should it be taken into a hot workroom and be allowed to remain there for even a few hours. It should then be shaped roughly to the required pattern and placed in a steam box and thoroughly steamed. After this process it can be used for the most difficult work without fear of splitting. It is whiter than the other sorts, and a little more liable to a bluish discoloration. In the early part of the eighteenth century British boxwood was in great demand. Elwes and Henry mention that as much had been cut down at Box Hill within a few years (of 1712 A.D.) as amounted in value to £3000. Now, however, the report says that only £1 per ton can be obtained, and "even at that low price no one seems to want it." Since the war it has been more in request, and it is to be hoped that in the future its undoubted value may be recognised once more, and greater care taken in its preservation and use.

Holtzapffel says: "It is more curly in growth than the Turkey boxwood . . . preferred by brassfinishers for their lathe-chucks, as it is tougher than the foreign box, and bears rougher usage."

(2) ABASIAN.—This wood is unrivalled for use in the making of engraving blocks, for which purpose the diameters required are 4½ inches and upwards (formerly the minimum demanded was 6 inches, but the tendency has been to reduce this). Curiously enough, this most costly boxwood is demanded for printing on the cheap paper used in the thousands of illustrated catalogues now issued so extensively from shops. Cheaper boxwood, such as Persian, would produce a blurred illustration on a cheap paper, and it is found more economical to use poor paper and good boxwood than the reverse. It is imported in clean, straight, round pieces from about 2 inches up to 8 inches, though it is sometimes received in larger dimensions: it is generally very sound and free from defects. The price before the war was about £50 to £55 per ton, advancing since to £60 and £65, which is about the same as it was some few years ago. For a wood which is so slowly grown and is of such a close texture, the shrinkage in seasoning is considerable. A test case showed that on the radial growth the shrinkage in drying, measured on a diameter of 1¼ inches, amounted to 1/16 inch, but on the tangential growth it was as much as 3/16 inch.

(3) JAPANESE. *Buxus sempervirens*, Linn., var. *japonica*.—In Japan boxwood, or asame-tsuge, which is the Japanese name, is used for the best kind of engraving, but cherry (*Prunus Pseudo-cerasus*, Lindl., var. *spontanea*), of which the native name is yama-zakura, is also used, as it is more plentiful and less costly than boxwood.

BOXWOOD, EAST INDIAN. *Canthium didymum*, Roxb. Weight, 50 to 57 lbs. (Gamble). India, Ceylon.

Gamble says: "In Ceylon, its resemblance to boxwood has caused it to be called Ceylon boxwood. . . . Wood white (Ceylon) or light brown (India), hard, close- and even-grained." It is now rarely seen in England, and indeed has never been procurable except in small quantities. It is well grown; from 6 to 18 inches in diameter and about 3 feet long. It was used in the past to some extent for engraving, but was not found hard enough to yield good results. On account of its size large shuttles were made of it, particularly those which were used in the manufacture of silk.

BOXWOOD, KNYSNA. *Gonioma Kamassi*, E. Mey. Weight, 52 lbs. 8 oz. Africa.

The wood is a reddish-brown, rather deeper in colour than that of other boxwoods; it is sometimes stained a browner tint towards the sap edges. Of recent years a considerable quantity has been imported, in straight, clean, well-grown logs, in diameters varying from 5 to 12 inches, and sometimes a little more, many of the butts being fluted; it converts into sound, clean pieces of good lengths. It is favourably reported on for many purposes for which other boxwoods are used, but it causes some trouble to those who work it. Either the dust or some other objectionable quality in it inflames the nose and eyes, and causes feverish symptoms. The workmen seem to recover quickly and are not attacked a second time, although there is always a certain tendency to inflammation of the eyes.

In growth and characteristics it resembles the West Indian boxwood, except that the medullary rays are straight and not wavy.

BOXWOOD, WEST INDIAN. *Tecoma pentaphylla*, Juss. Weight, 59 lbs. 1 oz. West Indies, Venezuela, Brazil.

The colour of the wood is yellowish-white, rather brighter than that of the Turkish or British. The grain is close, firm, and smooth. It is a beautifully grown wood, often attaining the height of 70 feet, practically free from a single knot throughout its length. At the extreme top the tree branches out into a tuft of foliage. Large supplies are available within easy reach of the shipping ports. It is generally shipped cut into lengths of 7 feet or 2 metres and from about 6 to 14 inches in diameter, while occasionally there are larger pieces. This variety of boxwood is the only one for which the world's demand is increasing. In France and Germany, besides other uses, it is extensively employed for making small combs. In this country it is used for inlay work and banding in cabinets, and for marquetry; for handles of all kinds of tools, for brush backs, mathematical instruments and rules, barometer backs, and many kinds of turned work, but it is not sufficiently strong and tough to be satisfactory for shuttles. It is sometimes stained and used for black wood, for which it is very satisfactory. A very large quantity was consumed during the war for making "punners" or ramming rods for loading high-explosive shells, for which work it possessed the necessary tensile strength to make it very satisfactory.

It is liable to become rather discoloured or blue-stained if kept long in the log. It should be stored, as close piled as possible, in a place that is not too airy and is entirely shielded from all wind and sun, preferably below the level of the ground and in a slightly damp position, as it is very liable to crack and split. It should never be removed from one position to another while seasoning if this can be avoided.

The pores are exceedingly small and ill-defined, the growth being very dense. The medullary rays are very fine, close, and parallel, but wavy and ribbed.

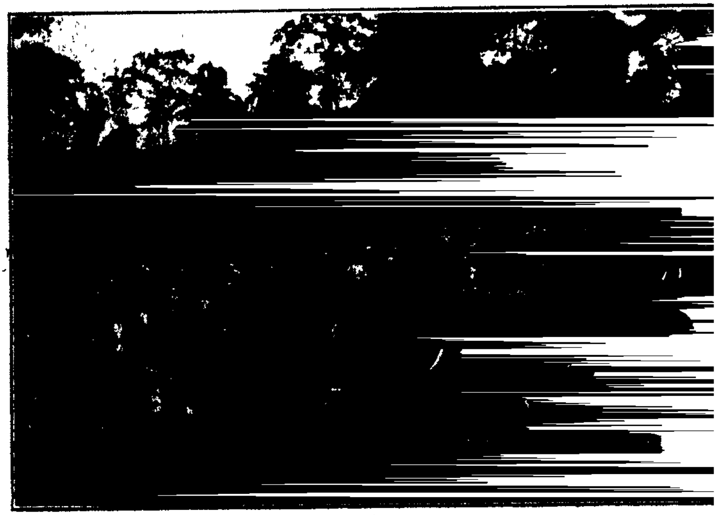
BRAUNA PARDA. *Melanoxylon brauna*. Weight, 66 lbs. (Betenden). Brazil.

According to *Brazilian Woods* this is "An excellent wood for props and railway sleepers owing to its durability. It furnishes a black paint and its sap is medicinal."

Baterden speaks of it as being "a tawny or grey wood, exceedingly strong, nearly three times as strong transversely as pitch pine, good for uprights and wall-plates of framed houses, stands wet and dry weather, and is much used for timbering in mines. It can be had in logs 60 to 70 feet long and up to 40 inches square. A first-class sleeper wood."

Brazil-wood. *Caesalpinia echinata*, Lam. The West Indies.

While the true brazil-wood is, correctly, of the above-named species, more than one botanical species has been supplied and some confusion has resulted accordingly. Holtzapffel gives brazil-wood as above, sappan wood as *C. sappan*, and brazilletto as *C. braziliensis*. Messrs. J. Gardner & Sons, who probably have the best available information at present, say that brazil, brazilletto, and Pernambuco wood have always been regarded as the same.



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The wood of these varieties is of a rich, bright-red colour, and is mostly used as a dye-wood, while the best pieces are selected for turning and for violin bows. For this last purpose, although many different kinds of timber have been tried, there is nothing that will yield the same result as the Pernambuco or brazil-wood, and many players will use no other kind on account of the peculiar strong, resilient spring only to be found in this wood. When planed it has a bright, metallic, lustrous surface, and shows fine, snake-like ripple marks.

A fairly satisfactory substitute has been found in tapang, a Borneo wood (*q.v.*). Although much lighter in colour, it resembles brazil-wood in many respects, even possessing the same ripple marks.

BRIAR-ROOT. *Erica arborea*, Linn. Southern Europe.

This fine hard wood, which is imported from France, is common to Southern Europe and Algeria. It is not, as is often supposed, the root of the rose briar, but of a very large heath. The name is a corruption of the French *bruyère* (heath). It supplies what is probably the only really suitable wood for making tobacco-pipes, in which connection its dark-brown, mottled appearance is familiar.

PHANTS, ANDAMAN ISLANDS.

BUCKEYE, OHIO. *Aesculus octandra*, Marsh. *Ae. glabra*, Willd. Weight, 28 lbs. (Hough). Eastern United States.

The timber of this tree, which is very similar to the English horse-chestnut, is probably the mixed product of *Aesculus octandra, Ae. glabra,* and perhaps also of *Ae. octandra hybrida.* It is not known commercially in the United Kingdom, but it is in considerable use in America for the same purposes for which horse-chestnut is in demand in this country. Gibson says: " Many an Ohio statesman of former times boasted that as a baby he was rocked in a buckeye sugar trough for a cradle." The same authority also mentions the use of this wood by the makers of artificial limbs, who consider it one of their best materials.

Bursera serrata, Colebr. Weight, 46 lbs. India.

The wood is of a reddish-brown, about midway between the colour of teak and mahogany, with a close, even texture, a straight grain, and rather a shiny surface, which becomes quite smooth from the tool. It should be useful for furniture and general cabinet work, and would make a good substitute for mahogany.

The concentric layers are marked by light, thin bands. The pores are very small, numerous, and regular. The medullary rays are exceedingly fine and small, and are only just visible with the lens (12 ×).

BUTTERNUT. *Juglans cinerea*, Linn. Weight, 25 lbs. North America.

This wood, apart from its colour, which is a yellowish-grey, resembles black walnut (*Juglans nigra*), *q.v.*, in all respects. Some years ago it formed a regular supply in the United Kingdom, but latterly this has been discontinued. It does not appear likely that it will play any important part in the supplies in the future.

CABILMA, CABIRMA. *Cedrela angustifolia*, Moç and Sesse (?). San Domingo.

This little-known timber from San Domingo is very similar to mahogany from the same region, and resembles it both in weight and texture; it is however much browner, though not of the same tint as sabicu. It has been and is rarely imported, but would be of use in the manufacture of high-class chairs, for it is strong and durable, and stands well when thoroughly seasoned. (My tentative reference of this wood to the member of the mahogany family, *Cedrela angustifolia*, rests on the authority of a San Dominican correspondent.)

Calophyllum spectabile, Willd. Weight, 38 lbs. The Andaman Islands.

Of a light red colour and smooth, shining surface, this wood somewhat resembles cedar in appearance. It is available in squares up to 30 feet long by 18 inches siding. There is a fair quantity which will probably soon be seen in European markets. It is used in the Andamans for rough work such as planks and packing-cases.

"Pores large, in scattered groups and wavy lines prominent on a longitudinal section. Medullary rays fine, very numerous, prominent in the silver-grain as long, straight, dark-coloured narrow plates. Concentric lines of soft tissue, interrupted, visible on a vertical section." (Gamble.)

Calophyllum tomentosum, Wight. Weight, 30 lbs. India.

The wood, which is the produce of the poon-spar tree, is of a light reddish-brown colour with dark gum streaks, and a slightly lustrous appearance. Gamble says: " The tree yields the poon-spars of commerce, but the spars are now in but small demand. . . . The wood is now in use for building and bridge work." Pearson says that it has been used in the Naval Dockyard, Bombay, as spars, masts, and crane shafts. It would be appreciated in the United Kingdom as a furniture and cabinet wood, and possesses many qualities that would bring it into favour.

The pores are of moderate size, irregular in position in wavy groups. The medullary rays are exceedingly fine and numerous, parallel and equidistant.

CAMPHOR WOOD. True camphor. *Cinnamomum Camphora*, Nees and Eberm. *Laurus Camphora*, Linn. Weight, 40 lbs. 11 oz. China, Formosa, Japan.

There is no evidence to show whether the timber which has been imported is the produce of either one sort or the other. Some sawn planks were imported from China in 1911 as true camphor, and were found to consist of 75 per cent of a wood which resembled camphor wood in colour only. This wood has a very strong scent of balsam of aniseed, and it was found to be soft and woolly, and to shrink and warp and twist in seasoning, quite contrary to the true camphor wood, which stands well; it was altogether unsatisfactory. The remainder was of a yellowish colour with dark red or reddish-brown streaks, and, having a very strong scent of camphor, was, no doubt, genuine camphor wood.

In 1912 Mr. H. J. Elwes had a number of planks and some exceedingly fine burrs imported from Formosa. They were of large size, ranging up to 4 feet square; they were very handsomely marked, nothing ever having been previously seen like them. There were also some planks of Formosan camphor wood in the Japanese Exhibition at the White City. This wood was less streaky and slightly browner in colour, harder in grain and of better quality, with the scent of camphor wood exceedingly pronounced. Camphor wood can hardly be said to be in commercial use in this country; it is generally seen in seamen's ship's trunks. In China it is largely used for boxes, linings of drawers, cupboards, wardrobes and receptacles for storing furs, where it is particularly valued on account of its immunity from the attack of insects or moth, and it is to be regretted that it is not more commonly appreciated in this country for use in such work. Foxworthy speaks of it as being durable for both interior and exterior work on this account. He says that it is durable in water, and has been valued from ancient times in shipbuilding. The greater part of the available supplies are used for the extraction of camphor, which makes the wood difficult and costly to obtain.

The pores are irregular in size and position, and are not very well defined. The medullary rays are neither regular nor clearly marked.

CAMPHOR WOOD, BORNEO. *Dryobalanops aromatica*, Gaert. Borneo, Sumatra.

Although Foxworthy refers to some species of *Cinnamomum* in Borneo and the Philippine Islands, the wood known in the United Kingdom as Borneo camphor wood is considered to be that of *Dryobalanops*. He says: "The Borneo camphor wood is obtained from species of *Dryobalanops*, of the family of *Dipterocarpeae*, and does not have an odour like camphor, except in the neighbourhood of the camphor deposits." Dr. Hose, who lived in Borneo for many years, says that the natives call the wood "padji"; and the name "kapor," which they pronounce "karpaw," was probably introduced by the Malays. He says that the real camphor tree of Borneo and Sumatra is *Dryobalanops aromatica*, and is known to the Malays as kapor barus, and several species of *Dipterocarpeae* resembling the camphor tree are usually known as kapor. Kapor-paya and kapor-bukit are distinguished by the locality in which they grow. Kapor-paya is a swamp tree growing in low country on alluvial soil, whilst kapor-bukit is a tree growing on hilly and undulating country, and resembling the swamp variety in every way except durability. He adds that these timbers continue to shrink more than the timber of *Dryobalanops*, and also that the different varieties of *Dipterocarpeae* are so numerous and so much alike that they are almost bound to become confused.

The timber is of a dull, light, reddish-brown colour and has gummy pores. It has an aromatic scent, but not that of camphor. After exposure to light and air it darkens somewhat to the colour of teak. It has a hard surface, and works with a good finish from the machine plane, in which it resembles yang, eng, and gurjun. It has been said that it will not be used by engineers and builders in this country as the timber is defective, but this cannot be substantiated, as the supplies have, on the contrary, been of faultless quality. It is this, and also the fact that large squares and long lengths can be obtained, which gives it its present important position as a useful and much inquired-for timber. As with the other species of *Dipterocarpeae*, the principal trouble is the difficulty of seasoning it satisfactorily. Boards 1 inch by 4 inches cut for flooring have shrunk with hot air desiccating, after being seasoned previously for six years. The best results have been obtained by natural seasoning for two years or more and then desiccating with hot air. The wood contains a kind of gum similar to that of gurjun. Any contact of iron or steel, if all moisture is not excluded, causes an unsightly black stain, and it is not safe, therefore, to use iron nails or screws if the work is to be exposed to damp. In England it appears to be durable in exposed work, but so far sufficient time has not been allowed for any reliable test. In such work the grain does not wear to a ridgy surface as with some hard woods, and there is not such a marked difference between the soft and hard grain. In this respect it is excellent for floorings. The grain is not fibrous, and its hard but not too slippery surface withstands the wear of shuffling feet or of nailed boots. It is also a valuable timber for general constructional work. One or two authorities in Borneo report it as a good wood for all purposes, and it is much valued in its native country, where, if it were not subject to the attack of white ant, it would be much more extensively used.

The pores are regular in size and position; the medullary rays are well defined and parallel.

CAMPHOR WOOD, FORMOSAN. *Machilus Thunbergii*, S. and Z. Weight, 41 lbs. Formosa.

This wood must not be confused with the true camphor of Formosa (*Cinnamomum Camphora*), from which it is very different. It is of a rather dirty-brown colour, but with a very bright lustrous surface which, with its lighter and darker marking, gives it a very pleasing appearance. It possesses a slight aromatic scent, though not that of camphor. It would be useful as an attractive cabinet or decorative wood, for in colour and appearance it is quite unusual. Mitsui & Co. give its estimated quantity available as 5,000,000 cubic feet.

The pores are small, very regular in size and position, and very clean and clearly defined. The medullary rays are fine, clearly defined, parallel, and equidistant.

CANALETE. Source unknown. Weight, 51 lbs. 13 oz. West Indies.

This wood is dense and hard, and has been imported in round pieces from 6 to 10 inches in diameter. The heart-wood is of a deep, purplish-lilac colour marked with thin black streaks running with the grain, and having a bright metallic lustre. The sap-wood, which is from ¾ to 1¾ inches wide and sometimes more, is bright yellow. The wood is fairly sound-hearted, free from cuppy shakes, stands well, and for some purposes should be a good substitute for lignum vitae. It is also useful for tool and knife handles, turnery and walking sticks, and makes a handsome butt-end for billiard cues.

The wood is marked by alternate concentric bands in which pores are more or less numerous. These are invisible, but their positions and scattered arrangement are indicated by a white halo surrounding the groups and slightly linking them tangentially. The numerous fine medullary rays are visible to the naked eye by reason of their light colour and sharp lines.

CANELLA-PRETA. *Nectandra mollis*, Nees. Weight, about 50 lbs. (Baterden). Brazil.

Baterden applies this name to the species *Cumamodendron oxillare*, which he describes as a grey-coloured wood, and as one of the first-class sleeper-woods on the Bahia railways.

In *Brazilian Woods* canella-preta is spoken of as being strong and compact, and very much used for ceilings and panels.

CANELLA TAPINHOAN. Source unknown. Weight, 48 lbs. Brazil.

The wood is of a pale straw colour, and resembles Indian yellow wood and West African acacia. It is fairly soft and mild, lighter in weight and colour, and more open in grain than another Brazilian timber which is called tapinhoan. It is reported as being used in Brazil for under-water construction. It would form a good substitute for the plainer sorts of mahoganies.

The pores are rather uniform and regular and of a fairly even size. The medullary rays are fine and regular.

CANGERANA. *Cabralea cangerana*, Sald. Gam. Weight, 34 lbs. Brazil.

The wood is straight-grained, and of a bright-red mahogany colour, with a wide sap line which is of a bluish-red hue. It resembles the plainer and commoner sorts of South American mahoganies. It is reported as being used in Brazil for doors and windows, and being particularly notable in that it does not shrink, warp, nor bend, which good character is upheld by its appearance and texture.

The pores are small and ill-defined. The medullary rays are not traceable even with the aid of the lens (12 ×).

CARALLIA WOOD. *Carallia integerrima*, DC. Weight, 46 lbs. (Troup). India, Burma.

There is no regular import to the United Kingdom. The small quantity which arrives here usually consists of pieces nailed together in the shape of a square open tube, of which two sides consist of slats, the pieces being used as ventilation pipes for carrying grain cargoes, which, to clear the ship, are sold on arrival for firewood.

Troup thinks there is only a limited supply. The wood is hard, and very similar in texture to British-grown live oak, except that it is of a strong reddish colour. "[It] is very handsome and useful for furniture and cabinet-making, especially when cut to show the beautiful silver grain to advantage. . . ." (Gamble.)

The wood seasons well and does not warp, but is somewhat liable to crack. The trees are of medium size, and the timber should always be cut on the quarter; the open pores are very resinous.

Carapa moluccensis, Lam. Weight, 43 lbs. India, Burma.

Considerable quantities of this wood, in squares of 20 feet × 12 inches × 12 inches, are available. It is red to purple in colour and is hard and durable. It is suitable for furniture, and is also used in Burma for house- and boat-building and for tool handles and wheel-spokes.

Careya arborea, Roxb. Weight, 50 lbs. India, Burma.

A dark red, even-grained wood, this can be obtained in squares up to 25 feet × 12 inches × 12 inches. It is durable, and seasons and polishes well. It lasts well under water and is said to be teredo-proof. It is used for gun-stocks, building, house-posts, planking, and furniture; it might be well adapted for paving blocks. It is obtainable in large quantities.

Cassia Fistula, Linn. Weight, 61 lbs. India, Burma.

This very hard, heavy, close-grained wood is the produce of the Indian laburnum. It is of a brick-red colour, darkening on exposure to light. According to the reports it is obtainable only in small size, and is rather brittle and apt to split. It would be a useful wood for turning, inlay, and fine cabinet work.

The pores and the medullary rays are exceedingly fine and small, with short, light-coloured ripple waves following irregular lines.

Castanopsis brevi-spina, Hay. Weight, 41 lbs. Formosa.

The wood is of a light nut-brown colour marked with a pretty pattern caused by the pores. It takes a very smooth surface, showing the clash of the medullary ray when cut on the quarter. It has a very nice texture, and has every quality for standing well without shrinking or warping. It has never been imported into England.

The pores are rather scarce and irregular. The medullary rays are numerous and fine, and joined at right angles by similar white lines giving the appearance of a fine spider's web.

CEDAR.

Under this commercial name a motley of woods is included. In the first place comes the true cedar, a coniferous genus, *Cedrus*, of which there are three species or varieties: the cedar of Lebanon, the deodar, and the Mount Atlas cedar. Another coniferous type, the Port Orford cedar (*Cupressus Lawsoniana*) might more correctly be termed a cypress, for the tree is familiar in gardens under the name of Lawson's cypress. The pencil cedars, being the wood of several American species of *Juniperus*, are truly junipers and likewise conifers. All these woods possess a very fragrant scent. It is not surprising that the name cedar has popularly, and hence commercially, been attached to the cigar-box cedar, a West Indian wood derived from a tree (*Cedrela odorata*) which is in no way allied to *Cedrus*, but is a member of the mahogany family (*Meliaceae*). Other species of *Cedrela*, including the Indo-Australian *C. Toona* and *C. australis*, and the Paraguayan cedar *C. braziliensis*, are more or less fragrant and receive the name cedar.

The wood of *Cedrela* in many respects resembles mahogany, and is to some extent characteristic, so that the name has been extended to various American, African, etc., woods which more or less resemble in appearance those of *Cedrela*, though not necessarily possessing any fragrance or strong scent. Some of the woods belong to the mahogany family, some do not, while the sources of still others are unknown. Then again there is in British and Dutch Guiana, the so-called cedar, the product of *Protium altissimum*. The wood is not a true cedar, nor has it any of the characteristics, and it is entirely without the fragrant scent usually associated with that wood.

Further confusion arises owing to the fact that between mahogany and cedar woods of the *Cedrela* type there exist transitional forms, which are termed mahoganies or cedars according to the will of the vendor. Indeed in some of these mixed species from the West Coast of Africa it has been found that even the produce of one tree, and indeed, one side of an individual tree, has displayed cedar characteristics which were absent in the remainder. (See p. 58, *West African Cedar.*)

Beyond these commercial woods lie others, locally termed cedars, though unfamiliar in the English market: among such are the American conifers, red cedar (*Juniperus occidentalis*) and white cedar (*Libocedrus decurrens* and *Cupressus thyoides*), the red cedar (*Cunonia capensis*) of Cape Colony, the red cedar (*Acrocarpus fraxinifolius*, Wight) of Sikkim, and the New Zealand cedar pahautea (*Libocedrus Bidwillii*).

CEDAR, AFRICAN PENCIL. *Juniperus procera*, Hoch. Weight, 40 lbs. East Africa.

During 1910, according to the *Kew Bulletin* (No. 2193), 31,000 logs of this timber were imported into Germany from East Africa. The wood is of a dark-red or rose colour, harder, more brittle, and slightly heavier than that of *J. virginiana*. Though it has the fragrance of the latter, perhaps a little fainter, the wood has not been so favourably received in the United Kingdom, but on account of the inferior quality and scarcity of supply from other sources it is probable that its use will largely increase. For such work as panelling, provided that reasonable-sized pieces free rom defects were forthcoming, it would be superior to any other pencil edar yet imported, as it is of a closer texture. The quality is exceedingly ood, and it takes a sharp edge for either surface or mouldings.

When cut on the quarter the medullary rays are strongly marked, s in beech, and the surface of the wood presents a slightly lustrous ppearance. The concentric layers are marked by thin dark lines. The ores are exceedingly small although numerous, and the medullary rays re clearly and strongly marked.

Cedar, Central American. *Cedrela odorata*, Linn., and probably other species of *Cedrela*. Weight, 27 lbs. 9 oz. and 33 lbs. 1 oz. Honduras, Mexico, Cuba, West Indies, Panama; Central America generally.

The wood is imported in square hewn logs and in the round, ranging from 6 to 40 feet in length and over, and from 10 to 40 inches in squares. The timber from the different sources above-mentioned is sufficiently alike to classify it under one description. Logs from Honduras or Tobasco are generally larger and supply the largest dimensions; those from Jamaica and Cuba provide the smallest.

The wood is light red in colour, generally straight in the grain, open, porous, soft towards the heart, of light weight and rather brittle. Some logs, however, are beautifully figured, with wavy, curly, and mottled grain, which resembles the roe and mottle and fiddle-mottle figure found in mahogany. It exhales a very fragrant agreeable scent which is remarkably persistent.

The wood works easily, shrinks only moderately, and stands exceedingly well when seasoned. On account of its reliable nature and light weight it is valuable for veneering on for fitments for yachts, especially when built for racing, where it has been used both for plain or decorative work, the more figured wood, either solid or veneered, giving exceedingly handsome effects. It is also used for pattern-making, modelling, carving, and many kinds of furniture work, especially for the linings and drawers of cabinets, where the fragrant scent is agreeable, and is a protection from the attack of moth or any insect. The longer trees are much sought for to provide boards for planking dingheys, racing and pleasure boats, where the comparative strength and lightness of weight provides all that is required. It is used for wide panels for railway coaches, especially where curved, as it is pliable and can be safely bent for this purpose without splitting; also for the arms of telegraph signals on railways, where this wood appears to be the most suitable to stand the required strain. Formerly the figured wood, and especially the curls or crotches, were much used in veneers for panels for wardrobes, bookcases, and cabinets; in a great many of the panels for tallboy clocks beautifully figured cedar will be found. By far its largest use, however, is for cigar-boxes. It was undoubtedly originally chosen for this purpose to the exclusion of all other woods, partly on account of the scent harmonising with that of the tobacco leaf, but principally because its porous nature, whilst allowing the moisture in the wet cigar to free itself, also admits moisture from without when the cigar is becoming too dry, thus keeping the tobacco in its best condition. The cigar merchant, however, seems to have strangely forgotten this advantage, and having begun by pasting a label on the box, has gradually increased the use of paper and gum, until in many cases the valuable wood is entirely covered with a single or even double lining, rendering the box impervious to moisture from either within or without, and under such conditions almost any other kind of wood would be equally serviceable. Mr. Oakhill, of the Imperial Tobacco Company, says that there is a maggot which in the tobacco-producing States of America will attack a bundle of leaves of tobacco in their dry state and pierce through many layers downwards. This maggot will attack tobacco boxes in other woods, but has not been known to go near tobacco boxed in cedar, and if the maggot is in the leaf of any tobacco in such a box, it will not develop.

In transverse section concentric rings are marked by thin, light, concentric lines, within each of which typically is a distinct pore-zone of loosely arranged large pores. These rings may be tolerably even in thickness, or some (in Cuba cedar at least) may be excessively narrow, but even in the latter case the light line is succeeded externally by large pores; moreover, some of the broader rings may, at least locally, be devoid of a pore-zone. In both these respects these cedars approach, in structure, mahogany from the same regions. In transverse section the pores are instantly visible to the naked eye, by reason of their large size, whereas the medullary rays are fine and only just visible. The medullary rays are not in tiers.

CEDAR, FORMOSAN. *Chamaecyparis formosensis*, Mats. Formosa.

This wood is of a light yellow colour, a little deeper in shade than that of Swiss pine (*Pinus Cembra*, Linn.) or Port Orford cedar (*Cupressus Lawsoniana*), which woods it resembles in other respects, except that the fragrant scent usual in cedars is absent. It is a straight-grained, mild soft wood, capable of a very smooth surface from the tool, and it should be very suitable for sounding-boards for pianofortes, violins, or other musical instruments. There is no doubt but that this timber would become much in demand if a regular supply could be maintained. Messrs. Mitsui & Co. record that a supply of 40,000,000 feet cube is available.

The concentric layers are very clearly defined, and the rings are very close. The pores are exceedingly small, and difficult to distinguish. The medullary rays are very fine indeed, yet show clearly on the radial section in a manner similar to but finer than beech.

CEDAR, GUIANA. *Protium altissimum*, Marsh. Weight, 42 lbs. 12 oz. (fresh). British, Dutch, French Guiana.

Twelve logs of this timber, which in France is known as "cèdre-blanc," were imported from Surinam into London in 1914, being intended either for France or Germany, probably the latter, and diverted to England on account of the war. Although supplies are apparently available from British and Dutch Guiana, this import is the first on record for the United Kingdom, at all events for a great many years. The colour is a light nut-brown with rather a satiny lustre, which darkens considerably on exposure ; it has a close, smooth texture and a straight grain.

It is a useful timber and stands well under all conditions ; it should be better known, when its undoubted good qualities would soon bring it into favour.

The pores are regular and uniform, and are of moderate size. The medullary rays are numerous, clearly defined and parallel, and are easily discernible with the naked eye. There is a liability for the wood to develop very fine cracks on the line of the medullary ray.

The name "cedar" is also applied to the produce of *Icica altissima*, Aubl., a timber used in Guiana for making canoes.

CEDAR, MOULMEIN. *Cedrela Toona*, Roxb. Weight, 29-40 lbs. (Gamble). British India, Australia.

This tree, which is of considerable value, is known in most parts of India as toon, and in Burma as thitkado. It is soft, red, and fragrant, and in India is largely used for furniture because it seasons easily, works well, and is ornamental, taking a good polish. It must be well seasoned before use, otherwise it warps badly. In England and Europe generally it resists the action of moths and boring insects.

Being scented and open-grained, it is almost indistinguishable from Central American cedar (*Cedrela odorata*). For general purposes in the domestic arts it might be used in lieu of the better kinds of cedar from Cuba and Mexico, whenever these are scarce in the market. It is also used for cigar-boxes and for packing tobacco. As Laslett found in his time that the supplies were not mild enough for pattern-making, it would appear that later shipments have yielded a milder wood, since many samples have been seen of late which were eminently suited for this purpose. It is subject to heart and star shakes, and in seasoning is very liable to split from the surface if left long in the round or unconverted state. Mr. R. S. Pearson has made some very interesting experiments showing the manner in which this timber is affected by atmospheric changes and disturbances.[1]

Photograph by Basti Ram.

MOULMEIN CEDAR.

Received from U.P. Exhibition, Allahabad Exhibition, 1910–11.

In Australia this wood was, at least formerly, the "red cedar" (*q.v.*) widely used in building and the manufacture of furniture. The supply rom this country has decreased, while as regards India there is no rospect of any large supply in the future unless systematic planting is aken in hand; this work is well justified from the value of the wood nd the comparatively fast rate of growth of the tree.

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[1] *Forest Bulletin*, No. 15: "Note on the Technical Properties of Timber."

The annual rings are clearly marked by bands of wide and numerous ores forming the spring zone, outside of which the more scanty vessels are scattered. There are no concentric light lines meeting the rays at right angles. The large pores and fine medullary rays are visible to the naked eye in cross-section, and the rays produce a pleasing silver grain in the quartered wood.

CEDAR, PARAGUAY. Source unknown; probably *Cedrela* sp. (*C. braziliensis*?). Weight, 31 lbs. 15 oz. Paraguay.

About 1899 there reached London several cargoes of this wood, in the form of square hewn logs, varying in length from 10 to 30 feet, and from 12 to 30 inches wide or more. The logs were very sound and of good quality.

In texture and fragrance the wood closely resembles cedar from Central America, but appears to be harder, darker, and redder. It seasons and thereafter stands well, neither shrinking, warping, nor twisting. Trouble was experienced in the sale, however; as if offered as a substitute for cedar its extra weight was the cause of complaint, and when offered in lieu of mahogany the buyer complained that he had been given cedar. Probably its most general use, however, would be as a substitute for mahogany.

In transverse section the annual rings are well marked by a zone of large pores, within which is a thin light line (in my specimen the rings are all wide); the pores are visible to the naked eye, mostly open, but some contain a glistening dark substance; the medullary rays are visible and somewhat wavy.

CEDAR, PENCIL. *Juniperus virginiana*, Linn. Weight, 34 lbs. 11 oz. (very variable). United States, especially in the Eastern region; and *Juniperus barbadensis*, Linn., *J. bermudiana*, Linn., Georgia, Florida, Jamaica, and other islands of the West Indies.

The woods of the above species are practically identical in appearance and properties, and are used almost entirely for pencil-making.

The timber is generally imported in the form of square hewn logs or billets, but sometimes in the round, the sizes and quality of which have deteriorated steadily with time, so that it is now possible to obtain only small-sized faulty wood. Formerly large-sized pieces yielding panels 2 feet wide were procurable. The present supplies come mainly from Jamaica, Alabama, and Georgia. The northern-grown wood is unsuitable for pencil-making. This very fragrant timber (heart-wood) varies in colour from yellowish to purplish red, often recalling the tints of faded rose petals. Under the plane it yields a surface rivalling in smoothness that of marble, and in this possibly surpassing any other commercial wood. As it is soft and easily cut, and has a regular and even grain in all directions, it is eminently fitted also for carving. Pencil cedar has been used for panelling and decorative work, and in times past for many well-appointed buildings. A superb example of work in this wood is to be seen in the Reception Hall of the Skinners' Company in Dowgate Hill, which was executed shortly after the great fire of London (1666). Its fragrant scent is preserved to the present day, and is noticeable when one enters the Hall. Another old building in Coleman Street, pulled down by Messrs. Colls & Sons about 1902, contained some handsome panelling in pencil cedar, as well as two very fine carved mantelpieces and overmantels, all in Jacobean style. Some of these panels of sound, clean timber measured 2 feet in width.

When used out of doors in contact with the soil, the wood is extremely durable, and was formerly used for posts, shipbuilding, and so forth ; but the southern-grown pencil cedar is now far too costly to be used for purposes other than the making of pencils, and, to a limited extent, for furniture and decorative work, linings of cabinets and cases (in order to keep moths at bay, or for its aromatic scent).

The annual rings are distinct, but the medullary rays are invisible, and the resin passages are lacking.

CEDAR, PORT ORFORD. *Cupressus Lawsoniana*, Murr. ; *Chamaecyparis Lawsoniana*, Sarj. Weight, 33 lbs. 5 oz. Oregon, California.

In England this tree is familiar under the name of Lawson's cypress. In Oregon and California, as the trees often attain a height of 200 feet and a diameter of 12 feet even above the dilated base of the trunk, timber of large size is obtainable in the form of long boards or planks, free from all defects. The wood is light yellow or nearly white, with a glossy, satiny sheen darkening on exposure, and with a close, compact but rather soft grain. It is difficult, though possible, to produce a smooth surface, on account of a certain gumminess or toughness of the grain. The adhesive contents of the wood clog the tool so that it must be continually sharpened, otherwise the fibres are liable to be torn out. It is very strong for its weight, is straight-grained, stands well under all conditions, and is exceedingly durable. The wood is very fragrant and is stated to keep clothes-moths at bay. I have a wardrobe the linings and drawers of which are made of this cedar, and I regard it as a very great luxury. The delicate and agreeable scent appears as strong as when the wardrobe was first made, about eight years ago (1919).

It has been imported into England on a commercial basis, in boards and planks since 1911, but has probably never yet been estimated at its real value. Mr. F. R. S. Balfour has used a considerable quantity in fitting and joinery in his house in Scotland. It has been used to a small extent for boat- and shipbuilding, and, since the war, has been imported for aircraft construction, but for this purpose there has not yet been sufficient time to gauge its value. In the Western United States it has been used for buildings (including floorings), fence-posts, boats and ships, but Sarjent states that on the Pacific coast it is employed almost exclusively for matches. Durable in all situations, it is particularly so in contact with the soil; and has been used for railway sleepers. Elwes mentions the case of a tree that was perfectly sound though it had fallen more than two hundred years, and had been overgrown by a huge spruce tree, whose trunk was 7½ feet in diameter, and whose roots extended like the claws of a parrot around each side of the [cedar]-tree and locked underneath.

The annual rings are marked by the contrast between the wide, white spring-wood and the narrower, reddish summer-wood, the former grading gradually into the latter. As this is a coniferous timber no pores are present, nor do resin passages occur, though resin and fragrant essential oil does occur in this wood. The medullary rays are excessively fine and almost invisible, though causing a general indistinct radiating pattern on the cross-section.

CEDAR, RED.

There are many timbers which are known under this name, chief amongst which are the following:

Cunonia capensis, Linn.; Cape Colony. *Cedrela Toona*, Roxb.; India. (This is the Moulmein cedar (*q.v.*).) *Acrocarpus fraxinifolius*, Wight; Sikkim, Western and Southern India, Burma. *Thuja gigantea*, Nutt.; Western North America. *Juniperus occidentalis*, Hook.; Western North America.

Of these, with the exception of Moulmein cedar, little is known in the United Kingdom, nor are they in ordinary commercial use.

CEDAR, RED AUSTRALIAN. Source dubious. Weight, 52 lbs. 4 oz. Australia.

The wood is of a red colour, with a brighter hue than that possessed by Central American cedar (*Cedrela odorata*), which it otherwise strongly resembles in many of its characteristics. It is, however, heavier, harder, and generally more curly in the grain, and more figured, besides being less strongly scented. It has been imported in boards, planks, and logs, and some handsome furniture and fittings have been made of it.

Professor Groom says: "The red cedar of Australia is usually described as being derived from the Toon-tree, *Cedrela Toona* (see Cedar, Moulmein), and it doubtless was so at one time. But the supply of the wood has gravely decreased,[1] and I have no doubt that much of the 'red cedar' now supplied is not wholly derived from the Toon-tree. Stone, for instance, was supplied officially with authentic specimens of 'red cedar,' and describes them: his description convinces me that the specimens were not the wood of *Cedrela Toona.* Quite certain it is that our commercial specimen is not from that species. I rather suspect that it may be derived from a *Dysoxylum,* which belongs to the same family, and may even be *D. Muelleri,* Benth., the 'red bean,' of which I have not seen authentic specimens."

The wood is somewhat cross-grained, shows no distinct annual rings or growth-rings. In transverse section it reveals to the naked eye innumerable thin, concentric light lines; the pores are just visible, but the medullary rays are invisible.

CEDAR, TRUE. *Cedrus Libani,* Barrel; *C. Deodara,* Loudon; *C. atlantica,* Manetti. Weight, 36 lbs. 7 oz. Europe, Asia, Africa.

There are three different kinds of true cedars belonging to the genus *Cedrus.* The differences between them are so slight and fluctuating that all three are frequently included under one botanical name, *C. Libani*; sometimes, however, each is given a separate name as above. All are mountain trees; the first-named growing on Mount Lebanon, in Cyprus, and the Orient; the second being Himalayan, and the third African, and growing on the Atlas Mountains. All these are grown in English gardens. The timbers of the three kinds are almost indistinguishable. An easy way of identifying the three varieties has been mentioned to me, though it should be taken as general and not absolute. L. for Libani, l. for level (the branches extend from the tree in a more or less horizontal manner); D. for Deodar, d. for drooping (the branches generally droop); A. for Atlantica, a. for ascending (the branches generally slope upwards).

The sole supplies in England have consisted in those derived from the few fallen trees (of all three kinds) and one shipment of *C. atlantica* from Algeria in 1909.

In a letter R. S. Pearson wrote concerning the deodar: "This is one of the three most important timbers of India, the other two being teak and sal. This timber is too valuable in India ever to find a market in Europe." We can thus look for practically no supplies from India.

The light yellow timber yields under the tool a beautiful surface rivalling in smoothness that of the pencil cedar. Often, though not always, the wood is fragrant, and the aromatic scent of the burning wood may at times be so potent as to induce dizziness and headache. While the sap-wood is perishable, the heart-wood is remarkably durable. In this connection Gamble writes : " Deodar wood is very durable, probably, with Cypress, the most durable of Himalayan woods. Stewart mentions the pillars of the Shah Hamaden mosque at Srinagar in Kashmir, which

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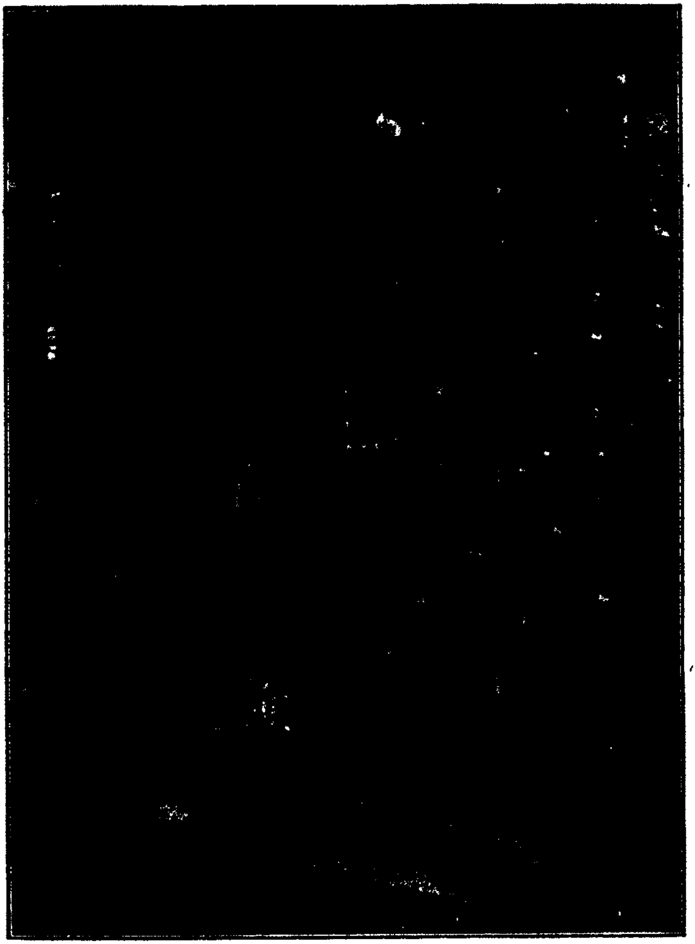
[1] Baker's *Cabinet Timbers of Australia.*



A GROUP OF DEODAR TREES IN THE HIMALAYAS.

date from A.D. 1426 and are now consequently (1901) 475 years old, as having been quite sound at the time he wrote. It resists the wet, also white ants, and apparently does not suffer much from dry rot." In the Palace at Versailles there is a richly carved gateway, above which is inscribed: " L'Hôpital des Chevaliers de St. Jean de Jerusalem dans l'Île de Rhodes." It is made of cedar of Lebanon, and despite its indubitable antiquity is in a state of perfect preservation.

The timber also possesses considerable strength, and Pearson mentions that it is used in India to make oars, bridge ladders, frames of parallel bars, axle-beds of transport carts (for the Ordnance Department). With these valuable qualities it is a pity that the wood derived from the fallen trees is in this country generally burned or wasted. Mr. H. J. Elwes, however, mentions one instance in which a cedar blown down on a lawn was most successfully used by the owner to supply the flooring and panelling of a good-sized drawing-room.

As *Cedrus* is a conifer, the wood shows no pores, nor does it possess any resin passages (though in certain specimens spurious resin passages are induced). The annual rings are clearly marked, but the medullary rays are invisible.

CEDAR, WEST AFRICAN. Sources various. Weight, 39 lbs. 11 oz. and 40 lbs. 12 oz. West Coast of Africa.

Among the many kinds of woods exported from the African West Coast, and having the scent and some other characteristics of cedar, there is one type that can be distinguished from all the rest by reason of its considerable resemblance to the cedar of Central America. The logs are imported in lengths varying from about 12 to 30 feet or more, and in squares of from 20 to 40 inches or more, either round or hewn square. The wood is of a light reddish-brown colour, rather redder than Cuban cedar, also heavier and " stronger " in character. Being somewhat cross-grained the wood shows a special type of banded figure, and requires a sharp plane to obtain a smooth surface. The logs are liable to star-shakes in the centre, making it difficult to obtain sound wide boards, though they are almost entirely free from the " cross-breaks " so common in West African mahogany. As this type of cedar stands well without warping or twisting, and has been obtainable at prices lower than that of American cedars, it has been used to a considerable extent as a substitute for the latter, despite its greater weight. A few finely figured veneer logs have realised very high prices, but the wood is not so favourably regarded for this purpose as mahogany, as, after cutting, the veneers of cedar are apt to crack up in drying.

The botanical sources of this type of cedar are not known. Professor Groom says: " We may perhaps hazard the guess that species of

Pseudocedrela are such, for it is known that African cedars are largely derived from this genus. Other genera (see Mahogany) also supply African cedars and mahoganies. To distinguish between the cedars and mahoganies of Africa should not in reality be difficult, though customs of the trade have made it so. Several so-called mahoganies have the same kind of thin, sinuous light lines shown in cross-section; among them are Sapeli, Warri, Jameson River, Sekondi, and one variety of Bonamba. Of these, the first two are scented; in fact, Sapeli 'mahogany' is stated to be derived from *Pseudocedrela*.

"The wood does not show in cross-section any distinctly marked annual rings or similar belts (though certain darker bands divide the surface into ring-like zones); but very numerous, fine, concentric sinuous lines are visible to the naked eye and cross the medullary rays at right angles; the pores are visible but rays invisible to the naked eye."

CEDAR, WHITE.

The following, all of which come from the United States, are the timbers known in commerce as white cedar. They are, however, seldom seen in this country, and are of little commercial value:

Libocedrus decurrens, Torrey.
Cupressus thyoides, Linn.
Thuja occidentalis, Linn. (see Arbor-vitae).

CEDAR, YELLOW. *Cupressus nootkatensis*, Hook. Weight, 20 lbs. (Boulger). Canada, United States.

This wood, which should perhaps be more correctly termed a cypress, is of a light yellowish-red, and has sometimes a very handsome grain. It is not known commercially in the United Kingdom, but is generally reported as being exceedingly durable.

CHAPLASH. *Artocarpus Chaplasha*, Roxb. Weight, 34 lbs. India, Burma, the Andaman Islands.

This wood has a very attractive golden-brown colour and a satiny lustre. As it is somewhat cross-grained it requires careful planing with a sharp tool. Although suitable for decorative cabinet work on account of its appearance it should not be used in large or unsecured work, as the nature of the grain renders it liable to warp to a certain degree. Gamble says: "It should be seasoned standing by ringing, so as to prevent warping when cut and sawn," and quotes Chevalier Paganini, who says he "considers it equal to or superior to teak for household furniture."

The pores are rather scarce, not large, and generally plugged, but show prominently on the tangential section rather prettily in a somewhat flaky pattern. The medullary rays are well defined, close, parallel, and irregular, and show on the radial section in minute flecks.

CHEESEWOOD. Species unknown — probably *Erythrina.* Central America.

The name cheesewood was given to some logs imported into Liverpool a few years ago. On arrival the timber was found to be exceedingly heavy, and as it was impossible to dispose of the logs, they were sent to Messrs. McArthur's sawmill to be converted into planks, as it was thought that in this form some use might be found for them. Mr. McArthur says that the sawyer was violently ill all night after sawing the logs, and his assistant more or less similarly affected. The planks were stacked in the usual manner for drying, and were found to be excessively heavy to handle, measuring only about 25 feet to the ton. Some time afterwards, being ordered to remove the pile, the men, to their great astonishment, found the planks lighter in weight than anything they had previously handled, the change having occurred in the drying. A sample of this wood measuring 2¼ inches in thickness, 5 inches in width, and 5½ inches in length, weighs only 4½ oz., and is probably the lightest piece of timber on record.

Notwithstanding the light weight, this wood possesses some considerable degree of strength, and stands firm under a fair amount of pressure. It might be described as "the softest timber of commerce." With only light pressure the finger-nail can be inserted to a considerable depth. On account of its strength and softness it should be useful for many purposes, but up to the present time its chief use has been for entomological cases.

The concentric layers of annual growth are clearly marked, and measure in places $\frac{5}{16}$ inch in thickness. The medullary rays can be distinguished by the naked eye as parallel and uneven. There are wide open pores, not very frequent, only situated between the medullary rays, sometimes wide apart, occasionally close together. Bright specks of gum shine out very white only between the pores.

CHEESEWOOD, TASMANIAN. *Pittosporum bicolor,* Hook. Tasmania, Victoria, New South Wales.

An alternative name is white-wood.

"This wood is yellowish-white, very hard, and of uniform texture and colour. It was once used for clubs by the aboriginals of Tasmania. It burns well, and should be tested for wood-engraving" (Irons, Reports London International Exhibition of 1862). "It is much esteemed for axe handles, billiard cues, etc. Specific gravity 874 (Mueller); dia. 6½ inches; height 20-40 feet" (extract from *Useful Native Plants of*

Australia; Maiden). (From private note 22/12/13 from Royal Botanic Gardens, Kew.)

CHERRY. *Prunus Avium*, Linn. Weight, 33–49 lbs. (Boulger). Great Britain, Europe, Asia Minor.

This wood when first cut is light red or pink, darkening on exposure to a deeper tint. It has a close, firm texture, and is capable of a very smooth surface from the tool. Although little valued for many years, it was growing in favour before the war, and since then has been in great demand for many purposes, particularly for chair-making and for the backs of brushes. According to Holtzapffel: "When stained with lime, and oiled and varnished, it closely resembles mahogany; it is much used for common and best furniture and chairs, and is one of the best brown woods of the Tunbridge turners. The wood of the black-heart cherry tree is considered to be the best."[1]

Mr. H. J. Elwes has panelled a room with cherry at Rapsgate Park, near Colesborne, which presents in all respects a very good appearance, equal to mahogany. In *Trees of Great Britain and Ireland* he mentions "that the pews in the church at Gibside, Northumberland, which were made in 1812 of cherry-wood, have not warped or shrunk in the least, the joints being as good as when made," although, the quotation goes on to say, "the sap-wood in some places is worm-eaten, the heart-wood is almost free from this defect," and this disadvantage of the sap-wood must be borne in mind.

The concentric layers are very conspicuous. The pores are exceedingly fine and numerous. The medullary rays are very strongly marked, and show clearly on the tangential as well as on the radial section.

CHESTNUT. *Castanea vulgaris*, Lam. Weight, 28 lbs. 10 oz. Europe.

Spanish or sweet chestnut attains large sizes and long lengths. In coppice-grown wood, straight, clean boles are procurable, which would yield good timber for large beams, while in that which is open or park-grown, very large diameters are obtainable. It is only the absence of the medullary rays which distinguishes this wood from oak, its appearance as regards colour, grain, and texture being similar; when chestnut is darkened by age or exposure it is exceedingly difficult to discriminate between the two woods. English trees, and especially those which are park-grown, are generally more or less unsound, and contain heart, star, and cup shakes, the last being the most common and serious defect. Many trees also develop a spiral growth, consequently the wood is wasteful in conversion.

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[1] Holtzapffel gives the source as *Prunus Cerasus*, but from his description it is probable that he confounded the dwarf cherry with the wild.

Elwes and Henry write : " The wood when young is as good or better than oak (because it has much less sap-wood) for fencing, gate-posts, piles, and hop-poles."

It is very durable for all forms of constructional work either indoors or exposed to the weather, while only to a small extent is it liable to the attack of insects or boring worms, or subject to fungous growth. Elwes speaks of a park fence composed of oak and chestnut, where after twenty years the oak was found much wasted, while the chestnut remained as sound as when put down. There is every reason to believe that in Northern France, before the sixteenth century, the craftsmen in wood were already aware of the advantages of combining the two woods, as in nearly all the work they executed in cathedrals and churches, chestnut is found mixed with oak. If this occurrence is accidental it is remarkable. The beautiful carved stalls and panels in the choir of the Cathedral at Amiens are certainly of mixed oak and chestnut, as is the woodwork of the church of St. Ouen at Rouen. The wood is very suitable for carved work and has been much used in this connection. Elwes quotes Sir George Birdwood as stating that " the late Mr. T. Blashill, who was architect to the London County Council, pointed out in a letter to the *Times* that the only instance he knew of chestnut wood in English mediaeval carpentry is that of the chancel screen of the church, formerly of the Knights of St. John, at Rodmersham in Kent. The Rev. A. H. J. Massey, Vicar of Rodmersham, tells me, however, that the chancel screen is a modern one of oak, with portions of an ancient screen of chestnut wood worked into it ; but the screen separating the Lady Chapel from the chancel is composed entirely of chestnut wood."

The large beam in the common room of Peterhouse, the oldest College in Cambridge, is generally supposed to be of chestnut, and without cutting it out, the utmost examination possible confirms the opinion. The panels taken from the wainscoting of a hall in Ireland were found to be of mixed oak and chestnut throughout, and indistinguishable except on examination with the lens. It seems probable, therefore, that chestnut has often been used intentionally with oak as a preservative.

Occasionally trees are found which are affected by the same brown colouring which is to be found in oak. One tree, to which Elwes refers, produced some very beautiful wood. This has been utilised for the doors and overmantel of a room at Rapsgate Park, Colesborne, where it presents a rich decorative appearance, very hard to equal.

A large trade is carried on in split chestnut laths for park fencing, for which purpose it provides a very economical as well as an ornamental appearance. It is also used for the backs of all kinds of domestic brushes.

The annual layers of growth can be clearly distinguished with the naked eye. The wide, open pores are duplicated, and are occasionally seen in rows of three in the spring wood; they contain small specks of bright shining gum. There are very minute pores in the autumn wood, though they are scarcely visible. The medullary rays can hardly be distinguished even with the lens (12 ×).

A similar tree, *Castanea dentata*, provides very large supplies of timber in America. Unfortunately the trees are attacked by fungus and a boring worm, so that of late years very large areas of the timber have been destroyed. The wood, the weight of which Gibson gives as 28 lbs., resembles in all respects the English chestnut. In America it is used for a great variety of purposes, these including fencing-posts and rails and railway sleepers. Gibson says that "the largest use by any single industry is probably by the manufacturers of musical instruments, though the honour may be divided with furniture, interior house finish, and coffins and caskets."

A large quantity of this timber is liable, as previously noted, to be riddled with small worm-holes. It is sold for veneering on, as the holes serve to hold the glue, and therefore secure the veneer more firmly. This wood has been imported to some small extent into London and Liverpool, but it is not much in favour. It has been used for cheap furniture and for coffin boards.

Chickrassia tabularis, Juss. Weight, 49 lbs. India, Burma, Andaman and Cocos Islands.

The wood, called in India Chittagong wood, is of a rather dark-brown colour, with a lustrous shining surface, a firm, close texture and a contrary hard and soft grain. It very much resembles in all respects the wood of Sapeli mahogany, and it has the same dark gum veins following the line of the concentric layers. It evidently stands well under all conditions, and is suitable for furniture and decorative work. This is one of the timbers mentioned in Mr. Gamble's list of woods which are available in fairly large quantities and likely to be worth trial.

The concentric layers are marked generally by thin, pale lines, but occasionally by dark blood or gum veins. The pores are small and regular. The medullary rays are invisible on the transverse grain, but show in very fine flecks on the radial section.

CHINGAL. *Balanocarpus* sp. Weight, 65 lbs. Borneo, Federated Malay States, the Straits Settlements.

This very hard, dense timber is of a warm brown colour. The wood takes a good surface from the plane, showing glistening marks of gum in the open pores. It is durable, and is used in its native country for constructional work and many other purposes.

The medullary rays are fine, clearly marked, and parallel. "It is very much the same as yacal, but may be distinguished from that wood by the fact that the tangential section always shows distinct parallel transverse lines (ripple marks)" (Foxworthy). The pores are numerous and irregular, and are largely filled with a gummy substance which shines brightly.

CINNAMON. Source unknown. St. Vincent.

A specimen of cinnamon wood, said to have come from St. Vincent, is in my collection. It is of a heavy, dense, hard, close-grained texture, taking a very smooth surface from the tool. It has a faint scent somewhat like that of cedar. The colour is a dull brown, resembling beefwood, and shading generally to a dark walnut tint. The wood would be excellent for turning.

Both pores and medullary rays are exceedingly fine and obscure.

COCOBOLO. Source unknown. Weight, 85 lbs. 14 oz. Tropical South and Central America (including Nicaragua, Panama, and Costa Rica).

The supplies of this wood are imported in the form of short cylindrical logs, half-flitches, and pieces of various shapes and sizes, which are from 1 to 3 feet in length, gnarled and twisted, and include knots, worm-holes, decayed heart, and other defective patches. The striped heart-wood shows alternate bright orange and deep red bands, the latter being often streaked with dark or even black veins. Its rich, handsome appearance sometimes has the effect, both as regards colour and marking, of tortoiseshell. It is hard and heavy; yields a fine surface from the tool, and is especially suited for turnery. When planed or turned, the smooth face is cold to the touch, like fine marble. When well polished this is a brilliant wood, and is used for the backs of brushes and hand glasses, handles of knives, forks, and tools, and in fancy cabinet-work. Cocobolo-wood deserves much wider use, but is insufficiently known. Supplies of good quality are scarce, while the demand is irregular.

In transverse section indistinct layers are seen, and may or may not represent annual rings. The pores are large, visible to the naked eye, scattered and not numerous, and have glistening contents. The extremely fine medullary rays are invisible, but with the magnifying glass stand out as light lines which are very numerous (being closer together than the width of the large pores). Linking the rays at right angles are very numerous similar light, thin lines, so that the field is divided into countless minute squares. The tangential section shows transverse striped pattern, indicating that some of the constituents are arranged in tiers.

COCUS WOOD. *Brya Ebenus*, DC. (?). Weight, 69 lbs. West Indies.

Supplies of this wood come in a somewhat irregular manner in round logs from 2 to 8 inches in diameter. There is some confusion as to the source of the supplies, though the probability is that shippers and merchants supply any botanical variety they can find which is sufficiently like to be given the name. Some of the wood known by the name of canalete would have passed for cocus-wood. It is hard and very heavy. The sap-wood is a very light yellow, and the heart-wood of a brown rosewood colour, streaked with markings of all shades to a pale straw yellow. It somewhat resembles a brownish-yellow Coromandel wood. It is used for policemen's truncheons, flutes, bagpipes, brush backs, handles of knives and tools, and all kinds of turnery and inlay.

The pores are very small and obscure; the medullary rays are exceedingly fine and even; they are parallel and so regular that they would almost appear to be artificial.

Cordia fragrantissima, Kurz. Weight, 50 lbs. India, Burma.

This is a handsome, dark-coloured, scented wood which seasons, works, and polishes well. It would be very suitable for decorative and ornamental work. It is obtainable in moderate quantities in squares 20 feet × 12 inches × 12 inches.

COROMANDEL WOOD. *Diospyros* sp. Weight, 70 lbs. 5 oz.

This name is one by which several different species of ebony (*Diospyros*) are known, when they possess a particular kind of marking and colouring. According to Holtzapffel, Coromandel or Calamander wood is *Diospyros hirsuta*, but Gamble gives it as *D. quaesita*. The description given by Holtzapffel is as follows: "The figure is between that of rosewood and zebra-wood; the colour of the ground is usually of a red hazel-brown, described also as chocolate brown, with black stripes and marks." He further adds that there are three varieties, 'the Calamander or Coromandel, which is the darkest, and the most commonly seen in this country, the Calemberri, which is lighter coloured and striped, and the Omander, the ground of which is as light as English yew, but of a redder cast, with a few slight veins and marks of darker tints."

Certainly of later years it is exceedingly doubtful whether these descriptions are confined to one, two, or even three varieties. Similarly marked and coloured wood has been obtained from several different sources *and varieties, all of which have been described for commercial purposes as ebony when first marketed, and as Coromandel wood when sold in the converted form, either as boards or veneers. Of these the supplies from* Macassar have produced the largest sizes and the best colouring.

Taking authentic specimens of three different sorts, (1) Macassar; (2) *Diospyros Melanoxylon*; (3) *D. Kurzii*, the face appearance is so similar that they might all have been taken from the same tree. The Japanese variety *D. Kaki* is often very similar, but the marking is on a smaller scale, and the light colouring is of a more yellow shade. There is also a slight difference between these three varieties in the transverse grain.

Macassar.—The pores are irregular in size and position, and are often filled with a bright, shining gum. The medullary rays are very indistinct; they are exceedingly fine and are very irregular.

Diospyros Melanoxylon.—The pores, which are smaller, are also much less frequent than in the Macassar wood. They are often filled with shining specks of gum; the medullary rays are stronger and more clearly defined.

D. Kurzii.—The pores are minute and very numerous, and the rays very indistinct.

Yet another source of supply of so-called Coromandel wood has been found in some occasional trees of Ceylon ebony (probably *D. Ebenum, q.v.*), which show the same marking and colour. If, therefore, at some much earlier date the name was applied to the produce of a distinct variety, there is little doubt that it has now become the common term for a particular form of marking and colour, which has been produced in several different species of *Diospyros.*

The wood is used for decorative furniture in various fashions. Beautiful tables and cabinets, pianoforte-cases, small ornamental boxes and jewel cases have been made with this wood, which has also been used for shop-front decoration and fitments. In the Victoria and Albert Museum at South Kensington, is a handsome armchair of Dutch manufacture, dating from the early eighteenth century, which is made of walnut and Calamander wood.

For description see Ebony, *Diospyros.*

COTTONWOOD. ***Bombax malabaricum*, DC.** Weight, 23 lbs. India, Burma, Ceylon.

Gamble describes this wood as "white when fresh cut; turning dark on exposure, very soft, perishable; no heart-wood, no annual rings. . . . The wood is not durable, except under water, when it lasts tolerably well; it is used for planking, packing-cases and tea-boxes, toys, fishing floats, coffins, and the linings of wells. If allowed to dry in the log the ood gets discoloured, so that to ensure white planking the trees should be sawn up at once and the planks dried separately."

This is one of the timbers mentioned in Mr. Gamble's list of woods which are available in fairly large quantities, and are likely to be worth rial.

The pores are scarce, but very large and open. The medullary rays re indistinguishable under the lens (12 ×).

RABWOOD. *Carapa guianensis*, Aubl. Weight, 38–46 lbs. (Stone and Freeman). British Guiana.

This wood has only been imported in small quantities and in boards nd planks, although it would appear to be available in long logs up to 0 feet, and of wide squares up to 3 feet in cross-section. It is of a dull, rownish-red mahogany colour, and assumes a glossy, lustrous surface rom the tool. It has a hard grain which, running in reverse directions, tears up under the plane so that it is difficult to obtain a smooth surface. As it is inclined to warp, and could only be used as a substitute for cheap mahogany, which can generally be produced from elsewhere at a less cost, it has little to recommend it for general use.

It has sometimes been incorrectly termed South American mahogany. A legitimate alternative name is carapa.

The pores are small and irregular, and show bright specks of shining gum. The medullary rays are fine, and parallel but irregular.

Cupressus torulosa, Don. Weight, 38 lbs. India.

The wood is of a pale salmon to yellow colour, with a straight smooth grain ; it resembles pencil cedar (*Juniperus virginiana*) but is of a slightly lighter shade. It has a strong and agreeable fragrant scent. As with the timbers of other varieties of cypress, it appears to be very durable, Gamble reporting it as even more " durable than deodar, as is shown by the results of buried sleepers of the wood at Dehra Dun. These pieces were put down in 1881 and taken out in 1892, and the Cypress wood was found to have resisted best of all . . . is frequently employed for temples in the Himalaya, as well as for images and poles to carry the sacred arks."

The concentric layers are marked by a strong dark vein, which is also conspicuous in the radial and tangential sections. The pores and medullary rays are hardly discernible with the lens (12 ×).

CURUPAY. *Piptadenia Cebil*, Grisebach. Weight, 73 lbs. 13 oz. South America.

In 1894 a cargo of hewn square logs of good length and size was imported into Liverpool from Rosario in the Argentine. The wood varies in colour from orange-grey to greyish-brown, with dark streaks and veins; some of it is reddish-brown, while much is handsomely marked with a wavy, curly grain. It has a faint aromatic scent, and the same cold, rather sticky feeling that is found in pyinkado (*Xylia dolabriformis*), to which wood, in other respects, there is some similarity. The timber has been used satisfactorily as a substitute for African oak for dock work, while some of the finely marked pieces have been converted into veneers, which give a beautiful decorative appearance.

Baterden says that curupay has "been a good deal used for piles and jetty work in the Argentine, and in such situations has lasted over thirty years."

It is a valuable wood which ought to be better known and in more general use.

The concentric layers are marked by very dark and light wavy bands. The pores are uniform, and the medullary rays parallel and regular.

CUSHIMUCHO. *Michelia compresa*, Max. Weight, 38 lbs. Formosa.

This wood possesses an unusual and attractive appearance which would demand attention if it were imported under commercial conditions. It is the colour of honey, of a dark variety, though sometimes it is a rich golden-brown, with a bright lustrous sheen. It has a close grain and a firm texture; it is capable of a smooth surface from the plane, although there is a slight contrary grain of harder and softer growth. It is altogether a unique and interesting wood which should be sought for in decorative and cabinet work.

The pores are exceedingly small and numerous, and are generally plugged. The medullary rays are equidistant and parallel, and show very finely on the radial section.

CYPRESS. *Cupressus sempervirens*, Linn. Weight, 20 lbs. (Baterden). Great Britain, Cyprus, Asia Minor.

This wood is not known commercially in England at the present time. Elwes says: "The timber is light brown in colour, hard, and close-grained. . . . The wood is easy to work, and gives off a penetrating agreeable odour. It is very durable, lasts indefinitely under water, and longer than oak when used for mine-props. In France and Italy it is considered excellent for furniture; and the doors of St. Peter's at Rome, which lasted from the time of Constantine to that of Pope Eugene IV., nearly 1000 years, were said to be made of cypress." He concludes by quoting Shakespeare, in *The Taming of the Shrew*, II. i. 353:

> In ivory coffers I have stuffed my crowns;
> In cypress chests my arras, counterpoints,
> Costly apparel, tents, and canopies.

CYPRESS, MARSH. *Taxodium distichum*, Richard. Weight, 33 lbs. 8 oz. Southern United States.

This wood is imported in the form of planks and boards of various qualities, but only of late years in any considerable quantity. It is yellowish-red, often nearly salmon-coloured. In the United States it is used so extensively that Gibson writes: "The uses are so nearly universal that a list is impossible." Another American authority, Hough, gives the following account of this timber: "Its great durability, immunity from the attack of parasites, and non-liability to great shrinking or warping make it one of our most valuable woods for all wood-work exposed to weather, for tank construction, cooperage, etc." These qualities, combined with a sharp segregation of the hard and soft grain, and with a scantiness of resin, should bring this wood into more general use. It is especially satisfactory for out-houses and green-houses, and where so used will probably outlast any other kind of soft-wood, even when unpainted. One such unpainted building in this country has survived for six years, and the wood, though subject to continual heat and moisture, is quite sound throughout. The English-grown wood appears to possess equally good qualities, and where available should be used for exposed wood-work. It differs from the American-grown timber that reaches this country[1] in colour, which is light yellow, and in appearance it recalls Lebanon cedar. There is a liability of the hard grain rising and the soft sinking, so that the wood is apt to show a ridgy surface.

Gibson has made some remarks which suggest that the remarkable durability of this wood is somewhat doubtful, but there is good reason to question his opinion. Professor Sargent, in a private letter (March 3, 1915) on this subject, says: "The wood *Taxodium distichum* is considered to be exceedingly durable, and I do not know on what authority Gibson has made his statement. It is not impossible, of course, that the wood of a diseased tree, or one that had grown under abnormal conditions, might be of poor quality."

A very large quantity was purchased by the British Government during the war for aeronautical construction, but it was found to be unsuitable, and led to deplorable results.

The wood, being coniferous, has no pores; the annual rings are marked by the alternation of the soft, open-meshed spring-wood and the hard, closer-grained summer-wood. The latter has one uncommon feature; it is apt to be divided into several concentric zones in each annual ring, by the intervention of narrow lines of wood like the spring-wood. The medullary rays are invisible. Resin-ducts are lacking (though resin does occur in the wood).

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[1] In the United States the timber varies, so that a distinction is drawn between the heavy "black" and the light "white" cypress.

Dalbergia cultrata, Grah. Weight, 70 lbs. (Gamble). Burma.

Gamble notes this as " A splendid wood, resembling ebony at a distance but with a totally different structure. Kurz says it is used for ploughs, bows, and the handles of spears. It has sometimes been used for carving. . . . *Wood black with dark purple streaks, very hard.*

" Pores moderate-sized, very scanty, in small patches of light tissue with large cells, joined by somewhat wavy concentric narrow belts of the same. These belts make a pretty grain on a tangential section. Medullary rays very fine, very numerous, short."

Dalbergia Oliveri, Gamble. Weight, 66 lbs. India.

This very beautiful wood is unfortunately commercially unknown in England. It is hard and close-grained : the colour is usually a salmon to rose-red, though it is sometimes darker, and almost of as deep a tint as rosewood. It is generally seen with more or less golden streaks, and has a bright, lustrous surface. There is sometimes a small, stripey or roey figure, resembling that of Ceylon satinwood. It would be difficult to imagine a more handsome cabinet wood, especially for work in the Empire or Sheraton styles. The wood stands perfectly well under all conditions.

The transverse section shows a pretty grain with light and dark wavy, ripple marks. The much scattered pores are scarce and rather large. The medullary rays are prominent, parallel but uneven, and crossed at right angles by similar white lines, which, with the rays, give the appearance of a spider's web.

DAMSON. *Prunus domestica*, Linn. Weight, 32 lbs. 9 oz. Europe.

This little known, but beautiful English wood can be used for decorative work with very effective results, and compares quite favourably with tulip or kingwood for banding, marquetry, or general cabinet work. It is capable of a very smooth surface from the tool. It is of a bright yellowish-red colour, streaked with bands of lighter and darker red, the general appearance being very similar to that of bleached or faded tulip wood.

The pores, though numerous, are exceedingly small, with one or two layers of slightly larger pores in the spring growth. The medullary rays, which are parallel, are very strongly marked and of a greater thickness than in most woods, they show very clearly on the radial section, as in beech.

DEGAMI-WOOD. *Calycophyllum candidissimum*, DC. Weight, 49 lbs. (Boulger). West Indies.

This wood is imported in straight, clean logs, with the bark on, ranging from 10 to 20 feet in length and 4 to 8 inches in diameter. The colour is yellowish-red, rather like lance-wood, though not so bright, or like a dull West India boxwood. It is elastic, bends well without breaking, and bears considerable transverse strain. It is used for a great variety of purposes and as a substitute for lance-wood.

EBONY. Mainly species of *Diospyros*.

The term ebony is usually applied to a black wood of great hardness, heaviness, and closeness of texture. The definition of ebony, however, is rendered difficult by several facts. True ebonies all belong to one botanical family, *Ebenaceae*, but there are black woods that belong to other families and yet vie with ebony in blackness, though differing from it in other characteristics, such as hardness or structure. Among such are African blackwood (*q.v.*) or Congo-wood, which in Germany is often termed Senegal ebony, though such a custom is unjustifiable as the wood in question is derived from the laburnum family. Incidentally it may be mentioned that certain woods, especially pear, are stained black and used as substitutes for ebony. Again the name ebony is also applied to woods that are not black. Among such the most familiar perhaps is green ebony (*q.v.*), which is derived from various woods belonging to diverse species. Moreover, woods which are true ebonies, even those from the genus *Diospyros*, are not necessarily black. A considerable amount of commercial ebony naturally shows a certain brownness of shade, and in order to conceal this, manufacturers of various articles blacken the wood with a stain. In fact it may be said that ebony is not always as black as it is painted. In all species of *Diospyros* the external wood is light coloured and is termed sap-wood. In a number of the species the central portions of the wood are more or less black. In some cases, such as *D. Ebenum* and *D. Melanoxylon* from India and Ceylon, this black wood forms a solid central core extending for a considerable distance along the trunk, but even in these species the black wood is liable to be arranged in the form of thick strands interrupted by light-coloured wood. In other ebonies the black wood is always interspersed with patches or bands of lighter coloured—light yellow to brown—wood: thus the marble-wood (*D. Kurzii*), from the Andamans, which is black and light yellow in patches, deserves its name, while Calamander wood (*D. quaesita*), of Ceylon, shows bands or streaks of black and brown. Still farther removed from blackness is the wood of *D. Chloroxylon* (British India), which is termed "green ebony" and is yellowish-grey in colour. It will be noted, too, that in several cases wood derived from the true ebony genus, *Diospyros*, are not termed ebonies;' two additional cases may be cited: the persimmon-woods of North America (*D. virginiana*) and of Japan (*D. Kaki*). Trees belonging to the ebony family but not to the genus *Diospyros*, also furnish ebony: such is alleged to be the case with *Maba Ebenus* of the Moluccas, and *Euclea Pseudebenus* from South Africa.

Its hardness, freedom from shrinkage and warping, powers of resisting decay and attacks by insects, as well as the smoothness of surface and finely polished appearance obtainable, cause ebony to be highly esteemed for particular purposes, including the making of piano keys, violin-bridges, flutes, handles of knives, handles and backs of brushes, rulers, mathematical instruments, walking-sticks, picture-frames, furniture, and ornamental cabinet work generally. Piano cases are made of wood which is stained to resemble ebony.

The conditions of formation of the black wood in ebony are not identical with those obtaining in regard to the heart-wood of ordinary European trees. This fact is well brought out in Mr. Herbert Wright's most valuable paper on the ebonies of Ceylon.[1] The succeeding information is culled from this source. "The occurrence of ebony [black wood] within the plant cannot be stated in terms of the age of the tree. . . . The black heart-wood occurs usually in the stem [trunk], but is often present in young twigs and roots. . . . The occurrence of the central black wood is often erratic, though most usually it decreases in volume from below upwards. . . . In some instances . . . the black heart-wood repeatedly dies away and reappears at different points along a given length [of trunk or branch]." The consequence of these facts is that the search for profitable ebony in ebony-trees is by no means a simple one. "The ebony is obtained by felling the tree and stripping off the peripheral sapwood. It is usual to fell all those trees which have attained or exceeded a breast-height circumference of 2 metres (6½ feet), providing the preliminary examination indicates the existence of a good proportion of solid black heart-wood. The preliminary examination usually consists of making an incision and determining the extent to which the discoloration [blackening of the wood] has proceeded. . . ."

The precise chemical nature of the black or deep brown colouring matters, largely contained in the cavities of ebony, is not finally established.

Apart from so-called "green ebony" (*q.v.*) the following have been or are the geographical and reputed botanical sources of commercial ebonies.

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[1] Herbert Wright, "The Genus Diospyros in Ceylon: its Morphology, Anatomy, and Taxonomy," *Annals of the Royal Botanic Gardens, Peradeniya*, vol. ii. pp. 22-55, 1904.

(*a*) ***Black wood*** **(occasionally interspersed with wood of lighter colour).**

Ceylon and India (" Bombay " : *D. Ebenum*, Koenig., and *D. Melanoxylon*, Roxb.) ; in Ceylon the wood of these and other species when interrupted by light bands is sold as " bastard ebony."

Mauritius : *D. Tesselaria*, Poir.

West Africa (Gaboon, Lagos, Old Calabar, etc.) : *D. Dendo*, Welw., and *D. mespiliformis*, Hochst.

Zanzibar : *D. mespiliformis*, Hochst.

Madagascar : *D. Perrieri*, Jumelle, mainly, also *D. haplostylis*, Boiv., and *D. microrhombus*, Hiern.

Philippines (also Indo-Malaya) : *Maba buxifolia*, Pers. The Indo-Malayan *D. Ebenaster*, Retz., may supply some of the black commercial ebony.

(*b*) *Streaked or patchy wood.*

Ceylon and India : Calamander or Coromandel wood : *D. quaesita*, Thw., streaked brown and black. (It is highly improbable that either *D. hirsuta*, Linn., or *D. oppositifolia* supplies any " Calamander " wood ; see Wright, *op. cit.*)

Philippines : " bolongata " and " camagoon," respectively *D. pilosanthera*, Blanco., and *D. discolor*, Willd., often very similar to Calamander wood.

Andaman Islands : " Marble wood," *D. Kurzii*, Hiern., black with very light, often creamy white, stripes or patches.

Celebes : Macassar ebony ; a wood of unknown botanical origin, varying in appearance, often reddish-brown with black bands, but sometimes variegated with other tints.

Japan : Kaki or Japanese persimmon, *D. Kaki*, Linn. f. ; black with varying amounts of light or grey bands or patches.

North America : American persimmon wood, *D. virginiana*, Linn., light in colour with little or no black heart.

EBONY, AFRICAN. *Diospyros Dendo*, Welw. Weight, 78 lbs. West Coast of Africa.

The imports are from Old Calabar, Cameroon, Gaboon, Cape Lopez, Ogowe, Burutu, and Niger. It is somewhat difficult to determine between the respective merits of the various districts. The shipments vary in quality, conditions, and colour. The wood is sent over in billets and also in short logs with the centres left in ; the billets are from about 5 to 10 inches wide, and from about 2 to 7 inches thick, the logs from 2 to 13 inches in diameter. Billets and logs are from 2 feet to perhaps as much as 8 feet. The billets are pieces split and chopped out from the main trunk of the tree with the sap and faulty places cut away. The following information was supplied by Mr. T. S. Leadam.

Old Calabar.—This was a good black ebony of fine grain, and was much in demand when obtainable, although almost always small in diameter and very short, being about ¾ inch in diameter and about 2¼ feet long. It was well prepared, and trimmed always in billets. The average weight of each piece was about 15 kilos, a piece weighing 20 kilos being rare. It was used for pianoforte keys, and there was a considerable demand for it in Sheffield for knife-handles. For some reason, at present unknown, the import has entirely ceased, but it has been said to be due to some local cause. Before the Old Calabar exports entirely ceased the wood came in larger sizes, and this suggests that it was coming from distant districts through the same port.

Cameroon.—In the absence of Old Calabar this wood seems to take the lead. It is generally of much larger sizes, often averaging from 25 to 30 pieces to the ton. The quality is good and the colour deep black.

Gaboon.—This wood is a very deep black, and is usually reliable, but the trimming and sorting has been conducted carelessly. At one time it was customary in Liverpool for the selling brokers to sort the parcels into three classes, which were called "flats," "billets," and "heavy." The "flat" grade consisted of all the faulty wood, and was selected on account of its deep degree of blackness for use in cutlery manufacture at Sheffield. The "billets" were the best wood of good sizes without centres. The "heavy" consisted of the large solid pieces, with or without centres, more solid than the "flat" but of any kind of shape. There was at that time a good demand for each class.

Ogowe.—This quality is the nearest approach to the Gaboon.

Gaboon.—A considerable quantity has come from a French source of supply.

Cape Lopez. Weight, 78 lbs. 4 oz.—The quality of this variety is very much like that of Ogowe but has the reputation of containing a greater supply of greyish colour. The pores are very variable in size, and are generally filled with a white gum. The medullary rays are very obscure and hardly discernible with a lens. There is a very faint, rather agreeable aromatic scent.

Burutu.—This is a coarse ebony, like an inferior quality of Macassar, somewhat long and irregular in shape, and it is very little in demand.

Niger.—A term generally used in America to cover all of the above imports except Burutu. There is, however, one quality known as "Niger" which, though generally good in colour, has a tendency to be streaked with grey.

Ebony, Burmese. *Diospyros burmanica*, Kurz. Weight, 55 lbs. India, Burma.

This is an inferior kind of ebony, which possesses such a small black heart and so wide a band of light (sap) wood that for European uses it could only be used for decorative inlay work or for golf club heads. The wood is hard, heavy, and close-grained, but is generally defective in the heart.

The pores and medullary rays are exceedingly fine, and scarcely discernible with the lens (12 ×).

Ebony, Ceylon.—Supplies have reached England from Ceylon for many years, but there has been no export on a commercial basis from India, although it may be expected in the near future. The imports from Ceylon consisted of what was, for ebony, exceptionally large-sized butts, which ranged up to 30 feet in length and 18 inches in diameter. The wood generally is not of such an intense black as is that from Africa, for nearly every piece contains streaks of a lighter or darker brown interspersed with the black. The wood generally is sound and serviceable, and on account of its greater length and size has for many purposes been preferred to the other varieties. This is especially noticeable in such work as shop-front fixtures and cases. It stands well and can be safely used in very small sizes, such as the fine framework for a show-case for jeweller's ware. The variegated form of this ebony has also been used. It is termed Coromandel wood (*q.v.*).

Photograph by G. R. Kern.

Logs of Ebony. South-West India.

EBONY, GREEN. Source dubious. (Possibly *Tecoma Leucoxylon*, Mart.[1]) Weight, 72 lbs. 2 oz. West Indies.

This hard, heavy wood is obtainable only in small pieces of round section, varying in diameter from 2½ to 6 inches. The sap-wood is yellowish-white, while the heart-wood is brownish-yellow, tinged more or less with bright bronze-green, and traversed with deep brown and yellow stripes. This dense wood, of nearly uniform texture. yields a very smooth bright surface which is cold to the touch. My specimen has no scent whatever. Another specimen, which was sent to me by Dr. Girdwood, is of a much darker and duller green, and possesses a most fragrant scent. It is evidently of a different species. It is used for linings and bandings in cabinet work and inlay, and is well suited for turnery.

Holtzapffel, writing of the wood imported in his day from the West Indies, including Jamaica, says: "It cleans remarkably well. The dust is very pungent and changes to red when the hands are washed with soap and water. The wood is very much used for dyeing, and it contains so much resinous matter that the negroes in the West Indies employ it in fishing like a torch."

In transverse section the concentric layers are marked by the alternation of light and dark concentric zones. The pores and medullary rays are invisible to the naked eye; with the lens the former, largely plugged, stand out as yellowish-white spots and the latter as thin, light lines. The pores contain a yellowish to dark-red substance.

EBONY, MACASSAR. Weight, 69 lbs. 2 oz.

This wood is imported in large billets and round logs which generally vary in size, ranging from 10 to 30 inches, with an average of 16 inches in diameter, while good lengths of 6 to 16 feet are procurable. It is fairly sound, and good sizes free from defect can be easily obtained. It is of a fairly dense, close grain, but is not so good in this respect as the ebonies of the West Coast of Africa. The colour ranges from dark brown to black, and a large proportion of the logs are streaked with yellow or yellowish brown, some very handsomely figured pieces being occasionally found. These are generally selected for special ornamental work, such as brush backs, mirror handles, and veneers.

On the tangential section the gum shines brightly in the slightly open pores. These are fairly evenly distributed, but are rather obscure and mostly plugged. The medullary rays are fine and very indistinct.

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[1] Professor Groom says that "The name 'green ebony' is given to several woods. One of these is *Brya Ebenus*, DC., from the West Indies. Another is *Tecoma Leucoxylon*, with which the name is specially associated. The sample agrees in many respects, but not perfectly, with the published descriptions of this. It also resembles the Nicaraguan wood known as 'bois d'or,' but from this and from *Brya* it differs in that its medullary rays are not arranged in horizontal series to form tiers. As opposed to greenheart the vessels are so fine that as delicate scratches along the grain they are invisible to the naked eye."

ELM, AMERICAN AND CANADIAN. *Ulmus americana*, Linn. *U. racemosa*, Thomas. *U. pubescens*, Walt. *U. crassifolia*, Nuttall. *U. alata*, Mich., and *U. serotina*. Weight, 44 lbs. 1 oz. United States, Canada.

As with all American and some Canadian timbers, the English timber merchant is confronted always with the difficulty of obtaining reliable supplies, on account of the fact that these always consist of the produce of several botanical species mixed indiscriminately. These supplies may vary from the fine, hard, white rock elm (obtainable from Canada twenty-five years ago in large quantities of good size) through less white and less hard transitional types to the soft swamp elm which is possibly derived from *U. alata* and is little wanted in England. Gibson quotes the respective weights of dry wood as " 40·54 lbs., 45·26 lbs., 43·35 lbs., 45·15 lbs., 46·69 lbs.," in the order named above, omitting *U. serotina*; but, according to him, *U. americana* is called rock elm if it grows on " stony uplands," and swamp elm if on low ground. It is, therefore, not difficult to account for the extraordinary differences found in both colour and density between the different supplies. Gibson states that it would be difficult, if not impossible, to identify the elms or any one of them by the colour of the wood alone. Until a few years ago American and Canadian elm was imported from Quebec in hewn square logs from 20 to 40 feet in length and 11 to 16 inches square and sometimes even larger, and a very small import still continues, but the cost is very high, while the quality deteriorates steadily. Most of that which is now imported comes from America in similar sized logs, in the round with the bark on.

The wood is whitish-brown in colour, hard, tough, and flexible, with a fine, smooth, close, silky grain; and as it has only a small quantity of sap-wood it can be worked up closely and economically. It is necessary, however, to remove the sap in the conversion of the log as, unlike that of the English elm, it is of a perishable character. If exposed to a current of dry air it is very liable to split with fine, deep shakes from the surface. Having this serious liability to rend in seasoning, the logs should never be left a week exposed to the influence of drying winds without some kind of protection. To preserve this timber, therefore, for future use, it should be treated in the same manner as the English common elm, namely by immersing it in water.[1]

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[1] It has also been used in aircraft manufacture. During the war the specifications drawn up by the Engineering Standards Committee for the supply of rock elm for aircraft limited this to the produce of *Ulmus racemosa*, but in practice it is doubtful if it would ever be possible to obtain supplies solely of one botanical species.

The wood is valuable for shipbuilding, boatbuilding and many uses where toughness and durability under water are required.

It is very slow-growing and the annual rings, which are very close, are distinctly marked. The medullary rays are clearly defined and parallel. The pores in the autumn wood, which are exceedingly small, appear like a series of very small, white, wavy bands, making a pattern at right angles to the rays. There is a rather indistinct line of larger pores in the spring-wood.

ELM, BRITISH. *Ulmus campestris*, Sm., etc. Weight, 36 lbs. 6 oz. United Kingdom.

This wood, although so well known, is not treated with the consideration which its merits deserve. There is little doubt but that scientific research could bring to light many more purposes for which it could be employed, than those for which it is at present utilised. It has been used by some for decorative work with very satisfactory results, as the colour and grain lend themselves to artistic effects, and for such purposes it is worth more attention. In Austria and Hungary, for instance, it is highly valued, being used particularly for open timbering work in halls and staircases. There is no evidence to show what botanical variety is used, but *Rugen Holtz* is often employed, and it is probable, though not certain, that this is the product of *Ulmus campestris.* The then British Consul at Vienna (1914) had his country house furnished with it, and told me that he considered it as good as oak and perhaps more ornamental. This example of the utilisation of home products rather than those of more exotic growth might well be followed in this country, which generally adopts the bad economic policy of the reverse system.

It must be borne in mind, however, that this wood is very apt to warp and twist, though where special measures have been taken, this difficulty has been overcome. As the first cost is very low, it would not be extravagant to use a means of protecting the exterior without interfering with the appearance of the wood, which would then be immune from the attacks of boring insects. There is little doubt that with the aid of preservatives it could be made more useful for many kinds of constructional work, as it is very durable under water and fairly so underground.

During the war it was tested for aeroplane work, though considerable discussion arose as to its suitability, opinion being strongly divided on the subject.

The pores in the spring-wood are large and open, and in the autumn-wood form a pretty pattern of complete wavy bands, which are so conspicuous as to be visible without the aid of the lens. The medullary rays are so prominent that it is strange that they do not show on the radial section.

Elm, Cornish. *Ulmus nitens*, var. *stricta*, Ait. Weight, 33 lbs. United Kingdom.

This tree produces a wood which is superior in quality and texture to either the common English elm or the wych elm, and more nearly resembles the quality of the American rock elm, although not so hard, tough, or white. According to Elwes and Henry, "It produces a remarkably tough wood, which is used by wheelwrights for naves, felloes, and framework of waggons, . . . and also formerly for making boxes in which gunpowder was compressed by an hydraulic press, as no other wood was found to bear great pressure so well." It also stands very well for the framework of lighter carriages and carts. Cornish elm was used for some old carved panelling which is carefully preserved in the church at Lantiglos near Fowey, but displays here its liability to be attacked by a worm or beetle, which has perforated some of the panels with holes. It is harder and of a lighter colour than the other English elms, and is capable of a smoother surface from the tool. There is also some difference in the transverse grain, which is more compact and dense, the pores being smaller and rather less in number.

Elm, Indian. *Holoptelea integrifolia*, Planch. Weight, 40 lbs. (Gamble). India, Burma.

This wood bears very little, if any, resemblance to the elms with which we are familiar in this country. The colour is a light, rather bright straw-yellow, while the wood has a clean, smooth, straight grain. Pearson says: "It is easily worked to a smooth surface, seasons well, somewhat cross-grained if cut radially." In India it has been found to be an excellent wood for brush manufacture, and is in demand for this purpose.

The pores are small and regular, not numerous, joined by pale, short, concentric bands. The medullary rays are exceedingly fine, well-defined, equidistant, parallel, and crossed at irregular intervals by continuous pale lines which may denote the concentric layers.

Elm, Wych. *Ulmus montana*, Sm. Weight, 33 lbs. 1 oz. Europe, America.

This wood, while very similar to that of the common elm, is more valuable and can be used for many more purposes. It is milder and more straight in the grain, and is not so liable to twist or warp. It is used for boat boards and other shipbuilding requirements.

The characteristics are similar to the ordinary elm, but the pores are more open, and decrease in size with an even and regular gradation, through the spring-wood to the outermost layer of autumn-wood.

EMPATA. *Pterocarpus Rassak.* Weight, 54 lbs. Borneo.

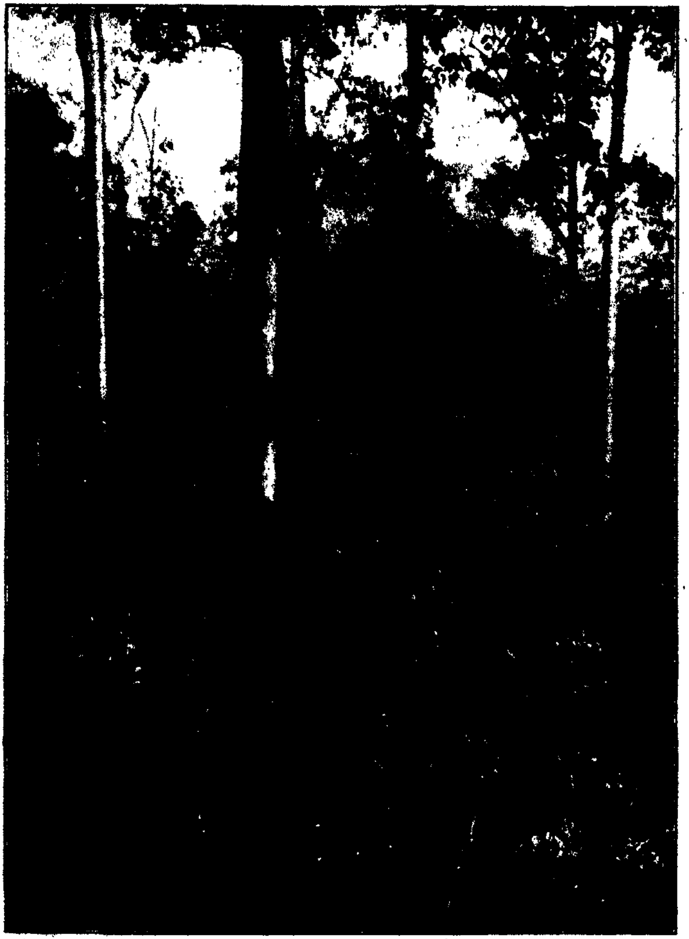
This timber is close-grained and hard, and much resembles the grain and colour of false acacia (*Robinia Pseudacacia*), but is of a deeper tint. The wood is durable but somewhat liable to warp.

The medullary rays are fine, clearly marked and parallel, but not equidistant. The pores are numerous, uneven, and irregular, and are sometimes partially filled with resin.

ENG. *Dipterocarpus tuberculatus*, Roxb. Weight, 39 lbs. 4 oz. (my sample); 50–59 lbs. (Gamble); 55 lbs. (Brandis). Burma.

In the United Kingdom the name "eng" is most commonly used, while in its native country the term "in" is usually employed to designate this wood. It is a straight tree attaining, according to Troup ("Forest Pamphlet," No. 13), "the height of 80 to 90 feet with a girth of 8 to 10 feet, but it may attain a height of over 120 feet and a girth of 15 feet." The timber is of a dull reddish-brown colour and has gummy pores. It has a pleasant and aromatic scent, which can pervade a room and is fairly persistent. The wood greatly resembles Borneo camphor-wood, Siamese yang, and Andaman gurjun wood. Concerning this last, Sir D. Prain, in a private note, points out that "the Gurjun of Chittagong, or Kanyin of Burma, are in botanical characters difficult to separate from *D. laevis*, and indeed they are generally considered identical. Yet within what is thus treated as one species the natives had two distinct things which they recognized readily as Telia (from tel or teli-oil), the tree that yielded the wood oil, and Denlia, a tree with a good, strong yet light, wood, used among other things in the poles of palanquins (known as Denlis). The wood of this Gurjun or Kanyin tree is very like that of the Eng (*D. tuberculatus*) which also yields a wood oil, or oleo-resin. The timber of the Eng is very similar in colour and grain to that of the Kapor or Camphor tree of Sumatra and Borneo (*Dryobalanops aromatica*)." Sir D. Prain says that he thinks that this tree "does not contain pockets of camphor, but that it may at times. If there be a timber which habitually shows pockets of camphor I do not know it, and should expect it to be some distinct species, and not *Dryobalanops aromatica*."

Eng is of hard texture, is straight-grained and works easily. When planed the resinous pores shine brightly. The timber is imported in sawn planks, clean and sound, from 10 feet to about 35 feet long, 7 inches to about 18 inches wide, and from 2 to 9 inches in thickness. As the trees are large and of great height, with clean, straight boles, even larger sizes could be obtained if required. "Were it not that Burmah has so many valuable timbers, and especially Teak, Eng would probably be in even greater demand" (Gamble). In India the wood is largely used for building construction and for boats. It is not there considered to be a very durable timber for work exposed to the weather, nor, according to Troup, was it found satisfactory for paving blocks in Rangoon, where it was used for this purpose, as it absorbed too much liquid and soon gave off an offensive odour. Where exposed to the weather, as in sleepers, etc., the white ant has destroyed it, and it has been found



Photograph by R. S. Troup.

ENG (*DIPTEROCARPUS TUBERCULATUS*), THEYAUNG FOREST, KATHA, UPPER BURMA.

to be much improved by Powellising. Sleepers subjected to this process have shown good results up to the present time.

In a later private note R. S. Troup says: "The importance of this timber lies a good deal in its great abundance. There is an enormous demand for the timber in Burma, and in many places the forests have been overworked, as well as wastefully worked. The value of In forests is, however, coming to be appreciated, and adequate steps will, no doubt, be taken to prevent wasteful exploitation and secure regular supplies for the future."

This demand, particularly in view of the continually advancing cost of teak, is certain to increase, both for home use in Burma and India, and for the United Kingdom and all other parts of the world, as the supplies of timber grow yearly more restricted. It appears to be useful for both external and internal construction work in the United Kingdom, although perhaps it is yet too early to speak with confidence as to its durability under exposed conditions. If its characteristics were more carefully studied, it might be used to advantage more regularly.

Like the product of *Dipterocarpeae* from Siam and Borneo, it has been improperly described as "eng-teak" and "yang-teak," which has given the impression that it was a variety of this wood (*Tectona grandis*), and being handled accordingly it has sometimes given unfortunate results. Unlike teak, it is exceedingly difficult to season, and indeed, without artificial drying it has perhaps never become properly seasoned. A sample 18 inches long 10 inches wide by 2 inches thick, cut over three years, was found to shrink nearly ¼ inch in thickness, and just over ⅜ inch in width, when subject to hot-air drying. If properly dried, eng is very suitable for floorings, as the grain is not too fibrous, nor is it hard enough to cause a slippery surface. The floor at Wigmore Hall, which was laid in 1905, is of this wood. An ugly black stain is caused, as with gurjun and Borneo camphor-wood, if iron or steel nails or screws are used with this wood where it is subject to damp.

Mr. Nesbitt, in a recent letter to the *Timber Trades Journal*, says that the timbers of the Dipterocarps contain an essential oil which is destructive to the timber. He points out that this constitutes the great distinction between teak and eng (which in England are sometimes confounded by the ignorant), as teak contains an essential oil that is a preservative not only to the timber, but to everything with which it comes into contact.

Eng, however, appears to be fairly durable when exposed in this country. This may perhaps be explained by the fact that the destructive essential oil, referred to by Mr. Nesbitt, may have exuded. The durability of the timber is not so marked when under or close to the ground, in which situations it soon begins to show deterioration. There is little doubt that a scientific means of preserving such a valuable wood could soon be found. Even when it is exposed to wet and dry above ground, it is quite durable; for under these conditions work under observation during twelve years gives quite satisfactory results. This is one of the timbers

Photograph by J. H. Lace, C.I.E.

Eng (*Dipterocarpus* sp.), Lower Burma.

mentioned in Mr. Gamble's list of woods which are available in fairly large quantities, and are likely to be worth trial.

The pores are irregular in size and position, and are partially plugged with resin. The medullary rays are irregular and somewhat coarse, showing in flecks on the radial section.

Eriolaena Candollei, Wall. Weight, 50 lbs. India, Burma.

This wood yields squares 20 feet × 10 inches × 10 inches. In colour it is bright salmon-red with brownish streaks. It is hard and close-grained, and seasons and polishes well. It is valuable for gun-stocks, cart wheels, for building purposes, and also for furniture and all decorative purposes.

Fagraea fragrans, Roxb. Weight, 60 lbs. (Gamble). Burma.

This timber, of which the native name is anan, is practically unknown in England, although some few years ago a number of logs described as junglewood were imported, and these have since been identified as being of this species. It is a very handsome, close-grained wood, of a light yellowish-red colour; it possesses a bright metallic lustre, and is capable of a very smooth surface from the tool. It is described by Gamble as being "one of the most important of the second class trees of Burma. The durability of the wood is attested by bridge-posts . . . said to be over 200 years old, and by posts in the moat of the old city of Tenasserim, 300 years old. . . . The most important quality of the wood is clearly its power of resisting teredo, and its great durability both in fresh and salt water."

If it became known in England, its use as a decorative wood would soon be recognised. It would be particularly prized for the making of chairs and for other work of like character.

The pores are very scarce and obscure, and form a pretty ripple appearance on the section grain. The medullary rays are exceedingly fine and numerous, but are not very clearly defined. There is an almost imperceptible ripple mark on the radial section.

Filicium decipiens, Thw. Weight, 65–68 lbs. India.

This is a very hard wood of a red colour; it is reported by Gamble as being strong and useful. It is probable that it will be exported in the near future.

"Pores small, in groups or short radial lines. Medullary rays fine, numerous, at unequal distances." (Gamble.)

FIR, SILVER. *Abies pectinata*, DC. Europe.

This wood is similar in appearance to the silver spruce of British Columbia; in colour and texture it may be described as midway between spruce (*Picea excelsa*) and yellow pine (*Pinus Strobus*). The grain is very smooth and silky. The principal use of silver fir in this country before the war was for the sounding boards (belly boards) of pianos and violins.

FREIJO. Source unknown. Weight, 46 lbs. 4 oz. Brazil.

This wood is somewhat like a slightly darker and heavier serayah, and is of a dull brick-red colour. It is very liable to split and would probably not be of sufficient value for export.

The medullary rays are very clearly defined and can be seen with the naked eye, very close and parallel, showing on the quarter in strong large, regular, oblong patches unlike any other wood. The pores are irregularly distributed and are not very large.

FURNITURE WOOD. Species unknown. Weight, 48 lbs. 1 oz. West Coast of Africa.

Many very different varieties of hardwoods have from time to time been brought to England, and for want of more accurate information have been called by the term "furniture wood." There has been such a great divergence of quality and appearance that it is difficult to know exactly the best manner of treating the timbers. Among these supplies, however, has been found one handsome and valuable variety that so nearly resembles in all respects Australian blackwood (*Acacia Melanoxylon*) that it suggests the theory that it is the same tree. The weight of my sample is exactly the same as one of the specimens of blackwood, while the colour and general appearance are also similar. There are the same dark gummy streaks and the same bright metallic lustre. It is only when the section end is examined with a magnifying glass that any apparent difference is manifested.

The annual layers of growth are clearly defined by thin light-coloured streaks, and the open pores are so evenly distributed that they would almost give the impression that they were artificial. The medullary rays are fine, parallel, very close and regular.

GANGAW. *Mesua ferrea*, Linn. Weight, 70 lbs. (Troup). India.

The above is the native Burmese name of the wood; it is also called iron-wood, and Indian rose-chestnut. A few logs of good size and quality have come to England. The wood is of a bright rose-red colour. Gamble says: "The timber is very strong, hard and heavy, and it is just its weight and hardness, and the difficulty of extracting it from the forest and converting it that leads to its comparatively little use. It gives good sleepers, as good as those of pyinkado, but the cost of extraction, conversion, and freight is so great as to make its extended use unlikely.

. . . In the Andamans it has given squares up to 60 feet long, 2 feet siding, but more usually they are 30 feet and 1 foot. The wood is very durable. It is used for building, for bridges, gunstocks, and tool handles." This wood appears to be valuable, and if properly known should be much in demand. It requires to be thoroughly seasoned, when it stands well and possesses a very nice decorative colour and appearance. It is one of the timbers mentioned in Mr. Gamble's list of woods which are available in fairly large quantities, and are likely to be worth trial.

The pores are scarce and strangely grouped. The medullary rays are very fine but distinct, and parallel; they are crossed in a peculiarly irregular manner by small, white wavy lines, the whole giving an effect as of a badly damaged spider's web.

Garuga pinnata, Roxb. Weight, 40 lbs. India, Burma.

The wood is reddish-brown with a handsome silver grain. It is even-grained and fairly hard. It can be obtained in quantity in squares 30 feet × 12 inches × 12 inches. It is used for such work as planking, canoes, and boxes.

Gluta travancorica, Bedd. Weight, 46–58 lbs. India.

The heartwood is dark red, very hard and close-grained, beautifully mottled with light and dark, *i.e.* black and orange, streaks. Its splendid colour and markings should rapidly bring it to notice as a valuable wood for furniture. It seems to season well and works and polishes admirably, and is distinctly one of the finest and most beautiful woods of India.

The pores are moderate-sized, scanty, and filled with resin. The medullary rays are very fine, very numerous, prominent, and visible in the silver grain as narrow bands. There are numerous pale, undulating, concentric lines, often interrupted.

GONCALO ALVES. *Astronium fraxinifolium*, Schott. Weight, 49 lbs. Brazil.

The wood is of a straw colour interspersed with streaks of dark reddish-brown. It is of a hard, close-grained texture, and capable of a very smooth surface from the tool. It has a very fragrant scent, especially when being worked. It is reported on as being considered one of the finest of Brazilian hardwoods, and as taking a high polish. It is used for furniture, such work as flooring and wainscoting, and in naval and civil construction. Certainly in wainscoting it would present a very handsome appearance. Shortly before the war a cargo arrived in London which consisted of a large number of logs of this timber which was termed

Brazilian walnut. It was not sufficiently known to meet with a very good reception, but after some little time the demand increased.

The pores are very small and rather scanty, uniformly placed, and generally plugged with a white substance. The medullary rays are very fine and are joined at right angles with fine lines, presenting an appearance as of a spider's web.

GRAPIA-PUNHA. *Apuleia precox*, Mart. Brazil.

This is a yellowish-coloured wood, with a clean, free, straight grain, moderately heavy, strong, and one of the most useful woods for planking or timbering. It attains only medium dimensions, but may be turned to account in many ways in the domestic arts. *Brazilian Woods* speaks of this timber as being of first-rate quality for building and naval architecture.

GREENHEART. *Nectandra Rodioei*, Hook. Weight, 66 lbs. 4 oz. British and Dutch Guiana, the West Indies.

The best quality of greenheart is that from British Guiana and the principal supply is from Demerara, whence it is received in hewn logs nearly square, from 24 to 65 feet and even longer, and from 12 to 24 inches square, with waney edges.

The logs are generally very straight in the grain, and remarkably free from knots and defects. They contain a considerable thickness of sap-wood, which, however, is not distinguishable from the heart-wood.

It has been pointed out that on rare occasions the sap-wood is attacked by a worm, which does not affect the heart-wood. The strength of this wood exceeds that of most others, whether it be tried by the transverse or tensile strain, or by a crushing force in the direction of the fibres. Tried by the latter process it exhibits a peculiarity unshared probably by any other timber except sabicu. It bears the addition of weight after weight without showing any signs of yielding; and when the crushing force is obtained, it gives way suddenly and completely with a loud report, nothing being left of the pieces but a loose mass of shapeless fibres. Very rarely it is liable, like sabicu, to a cross fracture of the longitudinal fibres. Although not subject to side shakes, it is somewhat liable to end splits, and great care has to be taken in sawing it up. Immediately the saw has entered the wood, and the air is admitted, the log may split with a loud report; on one occasion this happened, and the log flew upwards through the roof of the mill in which it was being sawn. On this account it is desirable, as soon as the log has passed the saw, to chain it round, securing the chain with strong dogs spiked into the wood, which will hold it sufficiently, so that all that can occur will be a severe split, without the risk of damage to the sawyers or saw frame.

It is largely used for piles for sea jetties and docks, as, although not entirely immune, the wood is partially proof against the attack of the teredo worm. Stone and Freeman quote W. T. Oldrieve as authority for saying that it resists *Limnoria terebrans* and teredo, and ranks next to teak in resisting white ants. The grain is smooth and fine, and cold to the touch. It is the general experience that this wood is poisonous, and workmen are very careful not to get splinters into their hands. More than twenty-five years ago, when the Port Elizabeth jetty on the south-east African coast was being built, sawn timber was imported direct from Demerara, and since this time a certain amount of sawn planks and boards has been imported. It was used rather extensively about fifty to sixty years ago for stair treads and other joiners' work if heavy wear was anticipated, and much of the woodwork in the old Post Office at St. Martin's-le-Grand was of this wood; it is difficult to understand why its use in this direction has been discontinued. It forms the best wood used solid for salmon, trout, and other fishing rods. A fine sample of greenheart can be made into an exceedingly small top joint for such a rod, and will bend to an extraordinary extent without breaking. The colour is of a pale yellowish-green, while sometimes it is quite dark with brown and black streaks. The black greenheart is considered to be the best.

CENTRAL FOREST CAMP, MIDDLE
Showing large gurjun trees (*Dipterocarpus turbinatus*), possibly more than

A shipment of Surinam greenheart, weighing 74 lbs. 12 oz. per cubic foot, was received in 1915, having been intended for Havre, but diverted to England on account of the war. The logs are of the same sizes as the Demerara and quite equal in quality; indeed, except that it appears to be rather heavier in weight and darker green in colour, there seems to be little difference in the two kinds.

The pores are scattered, numerous, and fairly regular. The medullary rays are very fine and close and sharply defined.

Grewia tiliaefolia, Vahl. Weight, 48 lbs. (Gamble). India.

This timber has hitherto been unknown commercially in the United Kingdom, but supplies are likely to be available in the future. It is of a brown colour, somewhat resembling walnut, and has a close, firm, hard texture, showing flecks of silver grain on the radial section. Amongst its uses in India, Gamble mentions shafts, masts, golf-clubs, tool-handles, oars, and all purposes for which elasticity, strength, and toughness are required.

E ANDAMAN ISLANDS.
an 500 in number, of which the value would be about £75,000.

GUARABU. *Terminalia acuminata*, Fr. Allem. Weight, 68 lbs. Brazil.

The wood is of a light purple colour, with a very hard, close grain and texture, and is capable of an exceedingly smooth surface from the tool. It resembles purpleheart, but is of a finer grain. It has a metallic lustre somewhat like brazilleto, and should be a good substitute for this wood for violin bows. It is reported as being used in Brazil for furniture, wheel-spokes, beams for civil construction, and flooring decks. It is apparently obtainable in long lengths and large sizes.

The pores are numerous and small, and are mostly filled with a gummy substance. The medullary rays are strongly defined, parallel but irregular, and joined at right angles by finer white lines, forming a spider's web appearance. The medullary rays show as in beech, but rather finer.

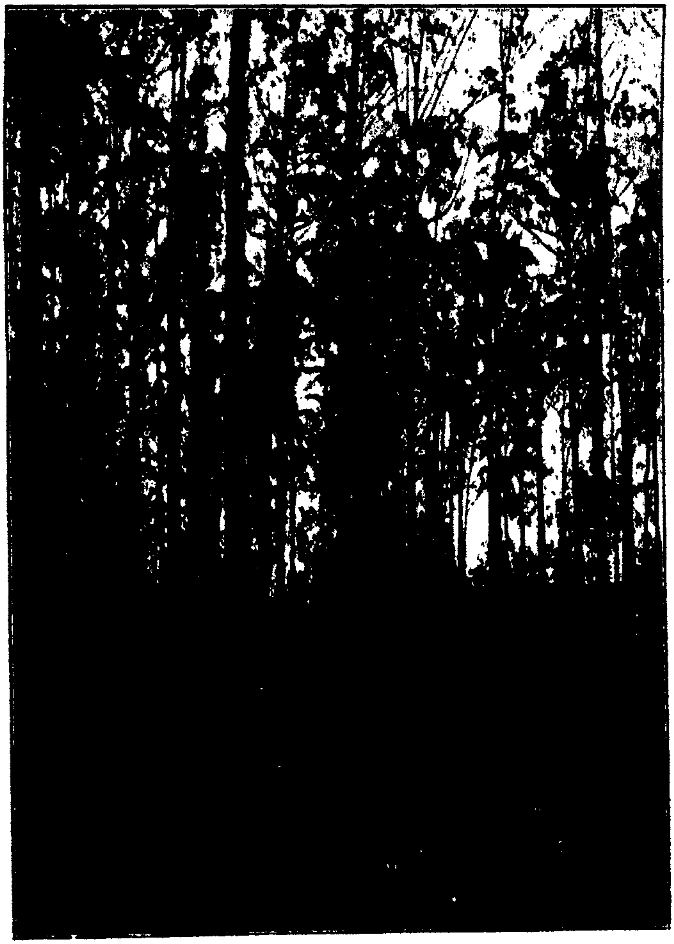
GUIZO. Weight, 50 lbs. Philippine Islands.

This timber has not been imported into the United Kingdom, and is unknown in ordinary commerce. From the limited opportunities available for judgement and reference, it would appear from the specimens sent lately by Mr. A. T. Gillespie, of Manila, to be in all respects similar to the sal (*Shorea robusta*) of India, and to prove as satisfactory and durable in use. The extreme weight of these timbers, which makes their cost when imported so high, will militate against the use of the wood, but if this difficulty is overcome it should be in great demand for sleepers and important heavy constructional work where hardness, heaviness, and durability are necessary.

For description see Sal.

GUM, BLUE. *Eucalyptus Globulus*, Labillardière. Weight, 43-54 lbs. (Stone). 69 lbs. (Post Office Compt.) Tasmania, Australia, India.

This tree, attaining the height of from 200 to 300 feet, with a diameter of 6 to 25 feet, is named blue gum from the colour of the young growth, which is of a glaucous tint. It has been planted in the Nilgiris in India, where it has grown rapidly, producing trees in thirty years with an average height of 143 feet and an average girth of 3 feet 11 inches, but so far has had the reputation of being but an indifferent timber tree, owing to the tendency of the wood to warp and split. It has been found to be serviceable and fairly durable, fence-posts having been in the ground for fifteen years. It has been planted in South America, where it has been used for sleepers, but has not given much satisfaction. The timber is of a pale straw colour, hard, heavy, moderately strong and tough, and has a twisted or curled grain. In seasoning deep shakes occur from the surface, and it shrinks and warps considerably. "It is specially esteemed for piles, owing to the large size that it attains and the comparative immunity it enjoys from the attacks of the teredo" (Carmichael Lyne, *Tasmanian Timbers*). This authority also states that the oldest wharf now in use was erected in 1868, and stood till 1902 without renewal, and mentions a sample of bridge-decking which was fifty years under foot traffic and is still hard and sound, while yet another timber formed part of the original Bridgwater Ferry punt built in 1818. The punt had been destroyed by blasting about fifty years before, and the wreck had been lying on the foreshore between high- and low-water mark, exposed to the attacks of teredo ever since. The timber, cut in 1894, showed no sign of decay. Stone quotes A. Mathieu, *Flore forestière*, as stating "it is the least valuable of the Eucalypti," but this does not seem to be borne out by the present record. Mr. Chas. Geddes of Fort Pirie prefers



Blue Gum (*Eucalyptus Globulus*) Plantations of the Nilgiris, India.

it to jarrah for girders, beams, and decking, in both strength and wear. He says he constructed 500 feet of wharf nine years ago, and used it in preference to jarrah and karri for cross-heads, girders, walings, sheet piles, and decking (quoted by K. C. Richardson in a report on Tasmanian Timbers). An immense quantity was used in the construction of the Admiralty Harbour Extension Works at Keyham in piles (fender piles and rubbing pieces). It has been used very extensively in England for railway waggon building, where it has given satisfaction. It has also been tried for sleepers, but does not seem generally to find favour for this purpose. The chairs make an almost clean cut through, which is probably due to the hardness and want of elasticity in the wood. The weight of the train passing over the chair compresses the softwood sleeper, which rebounds when the weight is removed, while the blue gum is too hard to compress and therefore crushes. Used as fencing it stands well, and after many years does not seem to decay, even without any protection of creosote or tar. It has been used extensively by the Post Office for telegraph and telephone arms, with satisfactory results, and the Comptroller, Mr. G. Morgan, provides a table of results of experiments made with various Australian and Tasmanian timbers for this purpose:

SIZE OF SAMPLES SELECTED FOR EXPERIMENT 54 INCHES × 5½ INCHES × 4 INCHES

Name of Timber.	Breaking Load in lbs.	Weight in lbs.	Specific Gravity.
N.S.W. Ironbark	24,750	74	1·19
Spero (Spotted Gum: *Eucalyptus maculata*)	24,000	54	·87
Tallow Wood	22,000	64	1·025
Blackbutt	19,570	57	·915
White Box	19,500	73	1·17
Forest Mahogany	19,200	59	·946
Turpentine	16,200	62	·997
Blue Gum	20,100	69	1·11
Jarrah	14,125	67	1·075
Karri	11,600	59	·95
British Oak[1]	...	54	·87

[1] In English Oak, "K" = 16,800 to 21,000.

It is satisfactory for platforms and deckings for wharves, and makes good hard-wearing flooring, although perhaps liable to become somewhat slippery. Blue gum, stringy-bark, and teak are all remarkable for their fire-resisting qualities: it is difficult to say which is the best in this respect. In September 1903, a disastrous fire occurred in the West India Docks, and sheds containing all manner of soft and hard woods were destroyed, some sleepers of blue gum and stringy-bark being the only timbers which remained; these showed very little sign of the heat and fire, and were only slightly charred at the edges.

GUM, RED. *Eucalyptus calophylla,* R. Br. Weight, 43 lbs. (Gamble). Western Australia.

Julius reports: " This tree is widely distributed, and of very handsome appearance, growing to heights of over 100 feet and an average diameter of about 3 feet. The wood is yellowish-red in colour, of lighter weight than the other local eucalyptus, though fairly dense and hard, and splits readily. It is apt to be much intersected with gum veins, which impair its suitability for important or permanent works of construction. The exuding gum has an acknowledged value for medicinal and tanning purposes. . . . The timber is very strong and tough, but not very durable under ground."

Gamble reports: " Pores moderate-sized, usually in radial lines of 3 to 6, joined by concentric white bars. Medullary rays fine, numerous."

GUM, SALMON. *Eucalyptus salmonophloia,* F. v. M. Weight, 66 lbs. (at 12 per cent moisture). Western Australia.

Concerning this timber C. E. Lane-Poole writes: [It is] " an exceedingly dense wood, the second strongest in Australia. It is questionable whether the gold mines of Western Australia, which have up to date yielded £80,000,000 of gold, would have been developed had it not been for this tree and its sisters Mulga (*Acacia aneura* and *A. stercsophylla*) and Gimlet (*Eucalyptus salubris*)."

GUM, SPOTTED. *Eucalyptus capitellata,* Sm. Weight, 58 lbs. 6 oz. Australia.

This is so much like tallow wood that it is difficult to distinguish between the two varieties. For conditions and uses it is similar in all respects to tallow wood (*q.v.*).

GUM, YORK. *Eucalyptus Loxophleba,* Benth. Weight, 67 lbs. (at 12 per cent moisture) (Lane-Poole). Western Australia.

" The wood is reddish in colour, is exceedingly hard, heavy, dense, and tough." This is the description given by Julius, who also reports that it " does not grow to heights much above 80 feet or diameters exceeding 3 feet, and the stem is apt to be more or less gnarled. . . . The principal use of this timber has been in naves, felloes, and all kinds of wheelwrights' work, its acknowledged peculiar excellence for which is recognised beyond the limits of the State. It is also employed for farming requirements and other local purposes."

It is spoken of as possessing very interlocked grain.

GUMBAR. *Gmelina arborea*, Roxb. Weight, 38 lbs. (Gamble). India, Burma.

The wood is of a pale yellowish-white and resembles white mahogany or prima vera in colour, texture, and grain, possessing the roe and mottle so well known in mahogany. It would be a very useful and attractive furniture and cabinet wood. Gamble reports it as "the chief furniture wood of Chittagong, and is in some demand in Calcutta, where it has been used for making the showcases of the Imperial museum. It has also been used on the Bengal North-Western Railway for the linings of railway carriages." He quotes Captain Baker, writing in 1829 as speaking of its use for ". . . organ pipes, sounding boards and other such work where shrinkage is to be avoided."

This is one of the timbers mentioned on Mr. Gamble's list of woods which are available in fairly large quantities, and are likely to be worth trial.

GURJUN. *Dipterocarpus turbinatus*, Gaert. f., and other species of *Dipterocarpus*. Weight, 42-50 lbs. Burma, Chittagong, the Andaman Islands.

This is a magnificent tree 150 to 200 feet in height. The source of the timber which has come to the United Kingdom is probably confined to the Andaman Islands; it has been received in clean, sound, sawn planks of moderate lengths and widths. Gurjun oil, which is extracted from the tree, is much in demand and is used for making torches, and for painting houses and ships. The timber resembles that of eng, but is of a slightly browner colour. It is useful in the same manner for the same purposes. It makes a beautiful flooring which stands well if artificially dried, and gives an agreeable aromatic scent which is noticeable on first entering a room and is fairly persistent even after some years. Parquet flooring of gurjun wood has been very much admired.

It stands very well in England when exposed to the weather, and the grain does not rise or wear to a ridgy surface, even when it is not protected by any paint or varnish. It can be used advantageously in all kinds of constructional work in the same manner as eng or in, and yang. As in eng, yang, and Borneo camphor-wood, if exposed to damp, an ugly black stain appears where iron or steel nails or screws are used.

The pores, which are very regular in size and character, are evenly distributed. The medullary rays are parallel and even, and are joined at right angles by similar lines, which are light, very fine, and exceedingly numerous.

HAREWOOD. Source unknown. Weight, 54 lbs. San Domingo.

This timber, known in London as "harewood," and in Liverpool as "concha satinwood," is imported in square-hewn logs, from about 8 to 24 inches square and 8 to 20 or more feet long. In San Domingo it is named "pino macho" (male pine), and so distinguished from satinwood, which is known as "espanello." At first sight these two woods appear to be very similar in colour, weight, and texture. Harewood, however, though yellow in colour and displaying a beautiful satiny lustre, is more dull and greyer or browner in tint, and is sometimes traversed by black "gum" streaks; moreover, on exposure to light and air its greyness gradually increases until with age the wood acquires the silver-grey hue characteristic of genuine old harewood and has been imitated by staining sycamore to produce artificial harewood (*q.v.*). The majority of logs imported show abundant roe and mottle figure, with a preponderance of the fiddle mottle effect. Some of these have realised very high prices (£3 or more per cubic foot) for veneers. When used for panelling and banding in cabinet work the wood produces attractive and artistic effects. It might with advantage be used for the backs of brushes of the highest quality. Harewood was employed in the form of marquetry, in a seventeenth-century Flemish and German backgammon board which is exhibited in the South Kensington Museum.

The annual rings (or zones of growth) are sharply marked by narrow light lines at the successive boundaries. The scattered little groups of pores are visible to the naked eye by reason of the light halo surrounding each. The numerous medullary rays are likewise visible.

Though the wood shows a striking resemblance to West Indian satinwood in the structure of the growth-rings and even in the great variation of their width, yet in my specimens of harewood the pores are larger, and they, as well as the medullary rays and boundary lines of the annual rings, stand out in cross-section more sharply from the darker general mass of the wood. It is possible that harewood and West Indian satinwood belong to the same family, if not to the same genus.

HAREWOOD, ARTIFICIAL. Stained sycamore or maple.

So-called "harewood" has in recent years been obtained by staining sycamore, or sometimes other maple, in such a manner as to produce a beautiful silver-grey wood with a metallic sheen. Several timbers, either white or verging on to white, are capable also of the treatment. The wood can be stained completely through. First practised in Paris, the process remained a secret one until taken up in Germany, and more recently in England. It has been found that the colour is induced by the action of iron salts (ferrous sulphate, for instance), which stains drops of tannin already present in the wood, particularly in the medullary rays. The chaste beauty of the treated wood has caused it to be used in the manufacture of handsome suites of furniture, in the panelling and furnishing of rooms in leading hotels and famous steamships, including the *Mauretania* and *Balmoral Castle*. Yet the beautiful furniture made of this stained wood cannot vie with the antique specimens in which genuine harewood has been used. Moreover, the pure silvery-grey gradually becomes discoloured with yellowish-brown, or changes to a bronze colour. It is claimed that under competent supervision this deterioration can be avoided, but I doubt it, and certainly up to the present all the work executed in this stained wood has in course of time suffered the change of colour.

Heterophragma adenophyllum, Seem. Weight, 47 lbs. Burma.

The wood is orange-yellow in colour, with occasional darker streaks. It is fairly hard, works and seasons well, and does not warp or split. It is extremely strong and elastic, and it seems probable that it will become a good aeroplane wood; it has been tried in India for that purpose. It is good for planking, and makes an excellent material for cabinet work. Gamble says that it is well deserving of being better known. It is obtainable in squares of 20 feet × 10 inches × 10 inches.

HICKORY. *Hicoria ovata*, Britt.; *H. laciniosa*, Sarg.; *H. glabra*, Britt.; *H. alba*, Linn. Weight, 46 lbs. 13 oz. Gibson gives the weight as 50–52 lbs. North America.

Although there is nearly always a use for which one wood is better fitted than another, this fact is hardly so well proved in any case more than with this timber. For many purposes there is no wood which can compare with hickory. The supplies are drawn from all botanical species of *Hicoria*, it being impossible to separate them, and the natural result is that there is a wide divergence in the quality of different shipments as regards soundness, toughness, and absence of faulty pieces. One of the worst faults encountered is that of the holes caused by a boring worm or beetle which destroys the value of a large quantity of the timber. It is imported into this country in clean boles with the bark on, but on the Continent before the war a high price was paid for split billets, which were highly valued and much in demand. The logs should be converted as soon as possible after arrival, as if left for any length of time, even though protected from the weather, they split very badly. When fresh the logs are of great weight, and the inexperienced are surprised at the cost of freight, the timber averaging as much as one ton and sometimes more, for 26 feet cube of Hoppus' measure.

The colour varies from almost white through shades of yellow to brown, with fine, straight darker lines crossing the surface. The grain is even and straight, and a very smooth surface can be obtained from the tool.

On the Continent, as in America, it has been largely used for cart-wheel spokes and felloes, carriage shafts and coachbuilders' work, all manner of bent work and hoops for casks, handles of picks and axes. In this country it is much in demand for golf shafts, for which purpose, on account of its springy toughness combined with its light weight, no other wood can compete. It is also used for pick and tool handles and bent work. The navy demands a considerable amount, and although perhaps on account of scarcity of supplies it has not been used to a very large extent in aeroplane work, many consider it for this purpose to be unequalled. It thrives in this country, and many good specimens of trees can be seen in various places; it should be more widely planted both for its utility and its beauty.

The pores are scarce and variable in size, some being very large; some are partially plugged. The medullary rays are very fine, parallel, and clearly defined.

HINAU. *Elaeocarpus dentatus*, Vahl. Weight, 36 lbs. New Zealand.

The Board of Agriculture, New Zealand, reports that this wood is "light dull-brown colour, heart-wood darker, tough, strong, and durable. Procurable in lengths of 20 feet and up to 12 inches in width. Used for fencing-posts, bridges, and culverts."

HINOKI, FORMOSAN. *Chamaecyparis formosensis*, Mats.; *C. obtusa*, S. and Z. Weight, 28 lbs. Formosa.

The wood is of a clean, bright yellow-brown colour, much resembling the appearance of cypress (*Taxodium distichum*). It is harder and heavier than the Japanese hinoki, and has more marked grain. It gives a strong aromatic scent which is not particularly pleasant, and is quite unlike the fragrant scent of Japanese hinoki. This is one of the useful Formosan woods, which till now has never been imported, but which, if a regular supply could be maintained, would become a very useful timber.

HINOKI, JAPANESE. *Cupressus obtusa*, Koch. Weight, 22 lbs. 9 oz. Japan.

The wood is of a pale yellow, straw colour with wavy marks caused by darker streaks, and possesses a lustrous sheen, while the scent is very fragrant and agreeable. Only a few logs have been imported, and commercially it is unknown. Elwes and Henry say: "No coniferous timber is now so highly valued in Japan for the finest buildings, as well as for interior work . . . and Sargent says that the palaces of the Mikado, as well as the temples, are built of it. . . . A large slab 3 feet across, brought to England by Elwes, which had been cut from a burr of this tree . . . was quite free from flaws, sound to the centre, and showed a very twisted and wavy grain; in colour resembling satinwood. . . . Hinoki is one of the five royal trees which were reserved for Imperial and religious uses in ancient times."

The annual rings, which are exceedingly close, are clearly marked by a strong dark layer. The pores and medullary rays are not distinguishable under the lens (12 ×).

HOLLY. *Ilex aquifolium*, Linn. Weight, 47 lbs. (Baterden). Europe.

The wood, which is white to grey in shade, is exceedingly close-grained in texture, and capable of a very smooth and hard surface. Generally the degree of whiteness, on the excellence of which its value rests, depends, as in many other cases of white wood, upon the time when it is felled, the manner of its conversion, and the care with which the converted parts are preserved. It should be converted immediately after the tree is felled, and the produce very carefully stored and stacked under cover in a moderately dry and sunless place.

Holly is chiefly valued for inlay work. Holtzapffel says: "Holly is the whitest and most costly of those woods used by the Tunbridge-ware manufacturer, who employs it for a variety of his best works, especially those which are to be painted in water-colours. It is closer in texture than any other of our English woods, and does not readily absorb foreign matters, for which reason it is used for painted screens, etc."

The beautiful Italian sixteenth-century walnut coffer, of which mention is made in the section on walnut, is inlaid with holly, which gives a very fine contrasting effect.

Gibson quotes the American varieties for much the same purposes, *Ilex opaca*, which would appear to be the principal one, and also *I. cassine*, *I. vomitoria*, *I. monticola*, and *I. decidua*.

The pores, which are exceedingly small, are very regular. The very clearly marked medullary rays are parallel and equidistant. They are very distinct on all surfaces but show most strongly on the tangential section, where they are exceedingly regular in their marking.

Hopea parviflora, Bedd. Weight, 60 lbs. India.

This wood is sometimes known as the ironwood of Malabar. It is the produce of the irumbogam tree. The wood is of a rather bright reddish-brown colour, with a hard, close, firm texture; it is capable of a very smooth surface from the tool. According to Pearson (*Forest Economic Products of India*), "The amount which it will probably be possible to procure in future will sooner increase than decrease, as the forests containing this species are brought under regular management." Gamble says that it gives logs of large size, averaging 25 feet in length, and containing 45 cubic feet. The wood is undoubtedly one which would soon make its good qualities known, if it were brought into more general notice. It possesses all the qualities which would make it stand well for decorative furniture work and turnery under all conditions.

The numerous pores are exceedingly small. The medullary rays are very fine and close, equidistant and parallel.

Hopea Wightiana, Wall. Weight, 54 lbs. India.

The timber is of a yellowish-brown colour, with a very hard, close, compact grain. My specimen appears a good deal heavier than the weight attributed to it, and is strongly marked with a fiddle mottle figure. It would be valued for brush backs, cabinet-work, inlay, and turnery, and perhaps for some of the purposes for which boxwood is used.

The pores are very small and numerous and are largely plugged. The medullary rays also appear in great numbers and are exceedingly fine and clear cut, parallel and equidistant.

HORNBEAM. *Carpinus Betulus*, Linn. Weight, 51 lbs. 13 oz. Great Britain, Continental Europe, America.

The wood is yellowish-white in colour, close in the grain, hard, tough, strong, and of moderate weight. There is no distinguishable sap or alburnum; it may, therefore, be worked up to great advantage. Hence we find it employed for a variety of purposes: it is useful in husbandry, and agricultural implements made of the sound and healthy wood wear well, as it stands exposure without being much affected by it. It is also used by engineers for cogs in machinery, a purpose for which it is well suited. The hornbeam tree, if pollarded, becomes blackish in colour at the centre, owing to the admission of external moisture and parasites. This renders it unfit for many purposes where a clean, bright surface is required, and generally it proves detrimental to the quality and durability of the timber. This wood, when subjected to vertical pressure, cannot be completely destroyed; its fibres, instead of breaking off short, double up like threads, a conclusive proof of its flexibility and fitness for service in machinery.

A considerable trade has been carried on of late years in Continental supplies of hornbeam, from France particularly, for use in pianoforte work; it is used especially for keys, for which it is highly suitable.

These supplies have been of a quality rather milder than most of the British wood, and of an exceedingly white appearance.

The concentric layers are clearly marked. The pores, which are very small and rather obscure, are very regular. The medullary rays are not very clearly marked, but show on the tangential section as fine, rather dark lines of uneven length.

HOROEKA. *Pseudopanax crassifolium.* New Zealand.

This wood, commonly called lancewood, is reported by the Board of Agriculture of New Zealand as follows: The colour is "lightish-brown, sometimes of a satiny lustre; dense, even, and compact. Procurable in short lengths and up to 4 inches wide. Used for wheelwrights' work."

HORSE-CHESTNUT. *Aesculus Hippocastanum*, Linn. Weight, 36 lbs. Great Britain, Europe.

The timber is white. If the tree be cut down in early winter, then sawn into boards and so forth, and carefully stored thereafter, wood of extreme whiteness may be obtained. If, however, the trunks are felled later in winter or are allowed to lie for any length of time, the wood assumes a yellowish-brown tint. It is of moderate weight, soft, fine-grained, but perishable. The timber has occasionally been used for veneers. In southern Europe it is said to have been used for fruit store shelves; the porous nature of the wood absorbs the moisture from the fruit, the preservation of which is thereby helped.

The annual rings are marked by a thin boundary line; the pores are invisible and scattered; and the medullary rays are so fine as to be invisible to the naked eye.

HORSE-CHESTNUT, JAPANESE. *Aesculus turbinata*, Bl. Japan.

This wood so nearly resembles the English horse-chestnut that it is unnecessary to give any further description. Some proportion of this Japanese species contains wavy, curly figure and is often mottled. On this account it is highly valued in Japan for decorative woodwork.

ICHII-GASHI. *Quercus Gilva*, Bl. Formosa.

This is a hard, heavy wood of a brick-red colour, with a firm, close texture capable of a very smooth surface from the tool. It has never been imported on a commercial basis, but according to Goto, "is valued in the making of agricultural and other tools and implements; also in making wheels and rudders." It resembles in its qualities English live oak, from which it only differs in colour.

The pores are very scarce and rather less than moderate size. In between the strong, bright, principal medullary rays are innumerable exceedingly fine, secondary rays which are only visible with the lens (12 ×).

INGYIN. *Pentacme suavis*, DC. Weight, 54 lbs. (Troup). India, Cochin China.

This is one of the timbers of which a specimen log was sent a few years ago to the Imperial College of Science and Technology, South Kensington. It is a very valuable wood for which many uses could be found in the United Kingdom if its good qualities were recognised. It possesses a very pleasing nut-brown colour, resembling teak, though it is a little lighter. It is capable of a smooth surface. On this point, however, Gamble says: " It resembles Sal in the peculiarity that on the vertical section it has alternate belts in which the grain changes, so that a very sharp plane indeed is required to smooth it. It is used in India for house-building and bows " ; also, according to Troup, for " bridge construction, piles, telegraph poles, boat-building, carts, shafts, strong articles of furniture, and bows ; suitable for trial for paving blocks." It is mentioned in both these authorities for its durability, while Foxworthy notes that it is indestructible in water.

The pores are arranged in belts which are made more clear by the halo surrounding them. The numerous fine, clear, equidistant medullary rays, which also show on the radial section as in beech but rather smaller, are crossed at right angles by similar irregular, fine white lines.

IPÊ PRETO or IPÊ UNA. *Tecoma curialis*, Fr. Allem. Brazil.

This wood is especially excellent for piles, booms, and harbour works. Another species, *Ipê tabaco*, described as one of the best woods of Brazil, is also used for timber and pile work.

IROKO. *Chlorophora excelsa*, Benth. and Hook. Weight, 41 lbs. 14 oz. West Coast of Africa.

This timber has been imported from several districts on the coast, but the best quality has come from Benin, in logs hewn square, ranging from 15 to 48 inches, and in lengths varying from 12 to more than 26 feet. It is described when sold as " iroko (African teak)," but it possesses little resemblance to teak (*Tectona grandis*) even in appearance, while in quality and texture it is quite dissimilar. It has also been sold under the name of " African oak " and not identified as iroko.

When first cut it is of a light-brown colour, which is inclined to bleach to a lighter shade after exposure to the air. As it is cross-grained, the wood does not leave the tool with a very smooth surface. It is sound and does not readily split, but the central wood is often faulty and therefore a little wasteful in conversion.

Iroko is described by Mr. H. N. Thompson as "the best all-round timber in tropical Africa—(and)—the most useful wood in West Africa." It is stated to be durable and to resist well the attacks of white ants (termites). Apart from its use in houses, it has recently been most successfully utilised to make heavy felloes for gun-carriages ; apparently the wood is thus exceptionally strong. It has also been found a splendid wood for the heads of golf clubs. There is little doubt that iroko will grow in favour and find new uses. This most useful timber can, however, in no way be regarded as a substitute for teak.

In transverse section concentric layers are formed by the occurrence at intervals of thin, concentric light lines of soft tissue. The pores are visible, and are linked together by shorter or longer light wavy lines that stand out well in the section. The medullary rays are invisible. The wood is cross-grained ; moreover, the grain is apt to be slightly wavy. The coarse vessels (pores) imbedded in soft, light tissue, score the surface with their furrows.

IRONBARK. *Eucalyptus largiflorens*, F. v. M. Weight, 74 lbs. 12 oz. Australia.

This is one of the most durable of Australian timbers. It is of a reddish-brown colour, and is rather liable to split.

IRONWOOD, EAST AFRICAN. Source unknown. East Africa.

This timber has not yet been imported commercially into the United Kingdom, but in common with some other East African woods it is now being exploited with energy, and the next few years will probably see a considerable development in export business.

The timber is of a hard, dense, compact grain and is apparently selected into two sorts, which are described as "ordinary" and "figury," although the distinguishing features between the two descriptions are hardly sufficient to make such a grading appear important. The wood is inclined to warp and twist, even in small sizes, to an extent which renders it doubtful whether it could be used for any important work. The texture is hard, with a marked difference between the soft and hard grain, so that a very sharp tool would be required to obtain even a fairly smooth surface. The colour is of a light brownish-yellow with dark streaks, and so strongly resembles the appearance of olive-wood that it would be practically impossible to distinguish between the two woods in any made article.

The pores are very numerous and regularly placed, and are blocked with a light-coloured substance. The medullary rays, which are parallel and regular, are exceedingly fine and clearly marked.

JACKWOOD. *Artocarpus integrifolia*, Linn. f. Weight, 40 lbs. (Gamble). India.

The wood is of a brilliant orange or gamboge colour, not unlike that of the ossage-orange (*Maclura aurantiaca*, Nutt), with a strongly-marked contrary hard and soft grain which requires a very sharp tool to obtain a smooth surface. It is not much used in the United Kingdom, but is largely utilised in India for all decorative and carpenters' work, for turning and inlay, and also for brush backs. It is reported as darkening to a mahogany colour with age and exposure to light.

The pores, which are numerous and rather large, are grouped in wavy bands, and are generally filled with a bright, sparkling gum. The medullary rays are very bright and well defined, parallel but not regular. On the tangential section they show strongly in numerous straight, light lines at right angles to the longitudinal grain.

JAMBA. *Xylia xylocarpa*. Gamble gives the weight as varying from 57 to 61 lbs. The Indian Peninsula.

This is the Indian species of *Xylia*, which until recently was regarded as identical with the Burmese pyinkado (*X. dolabriformis*, Benth.). Jamba is found in many parts of the Indian peninsula, being commonest on the west coast. The tree does not reach so large a size as Burmese pyinkado, and the timber is superior in quality to that species, but it tends to split in seasoning.

JARANA PRETA. Source unknown. Weight, 69 lbs. 7 oz. Brazil.

This hard, heavy wood is very liable to split ; it has somewhat the grain of greenheart. The colour is yellow-brown, alternating with a salmon shade in light and dark streaks. It takes a very smooth surface from the tool, and its qualities suggest that it would be useful for fishing-rods, walking and umbrella sticks. The transverse grain shows like a dark-coloured pine (*Pinus sylvestris*). The wood has a distinctly unpleasant smell.

The pores are irregular, small, and mostly filled with gum or oil. The medullary rays are clear and strongly defined, joined at right angles by very distinct and fine, similarly coloured lines making a kind of honeycomb pattern.

JARRAH. *Eucalyptus marginata*, Sm. Weight, 57 lbs. Western Australia, New Zealand.

The wood is of a bright brick-red colour and of close texture, with interwoven grain occasionally figured like mahogany. In general appearance it very much resembles karri, and great difficulty has been experienced in distinguishing between them. A simple means of achieving this is to burn a small piece of the wood. Jarrah will leave a black ash and karri a white.

The State Royal Commission on Forestry, reporting in 1904 on the available supplies, stated that virgin jarrah forest to the north of Blackwood River, which is suitable for milling, is estimated at 2,000,000 acres. To the south of this river there are also considerable supplies of this timber, while in addition to these areas there are several millions of acres of jarrah country not of sufficient commercial value for milling purposes, but which will afford immense scope for sleeper hewing.

HAULING A BIG TREE FROM THE FOREST.

Photograph by the kind permission of C. E. Lane-Poole, Esq., Forest Department, Perth, Western Australia.

Quoting the report of the late Mr. O'Connor, Engineer-in-chief of the State of Western Australia, Julius says: "For durability and general construction work of all classes, jarrah is undoubtedly one of the best of all State timbers. In buildings where there is much traffic, and also in private houses, jarrah planks furnish a durable, cleanly floor capable, if desired, of high polish. Skirtings, dadoes, rails, architraves, door frames, transoms, mullions, doorsteps, staircases, more particularly in public buildings and large houses, have been and are being increasingly made of this wood with very handsome results."

Jarrah is eminently suitable for high-class cabinet work, but care must be exercised in order to get it thoroughly seasoned before use. Some very handsome furniture and panelling has been on view at the London office of the Agent-General for Western Australia, and this can still be seen by appointment. It has been used in England for railway waggon and platform construction, and is in the third highest class for shipbuilding purposes at Lloyds. According to a report from the Chief Engineer of the North Eastern Railway Company, jarrah piles driven about ten or twelve years ago (1919) are still in good condition, and have proved quite satisfactory for wharf work. At Hartlepool, where the same wood was used for piles, there is only slight indication of attack by sea worms.

Concerning other uses to which it may be applied, Julius says that it " has been employed for telegraph and telephone poles and signal posts and has been found exceedingly suitable and durable; while its miscellaneous uses in the State generally, for almost every purpose and requirement of all the industries, are innumerable."

Contrary to general practice in the case of other chief timbers of the world, the heart-wood core of the *Eucalypts* is to be avoided, and specifications for cut jarrah timber should therefore require freedom from heart-wood, except in the case of piles, which are better round than squared. Sap-wood, on the other hand, rarely measures above an inch in thickness, and being often almost as hard as the inner wood, hardly needs to be particularly excluded, except in cases of special importance.

The British Fire Prevention Committee made some careful inflammability trials with jarrah timber a few years ago, with a view of obtaining reliable data as to its fire-resistance capabilities, when severe tests were applied. The results were regarded as generally satisfactory and as indicating that a building constructed of jarrah would be unusually resistant to fire, especially in the case of floors and floor-beams.

Quoting other State authorities with regard to the durability of this timber, Julius writes: " Its suitability for piles and any works requiring immersion in salt or fresh water has been practically noted. Specimens obtained from piles and girders sixty years old, and used in local harbours and bridges, appear to be perfectly sound and free from any signs of decay. If anything, the wood seems to be harder, more solid, and apparently more durable than freshly-cut timber. . . . It is destined to supply one of the most lasting of hard-wood timbers for a long time to come, at the least costly rate, to very many parts of the world." He adds: " Notwithstanding the superiority of this timber over so many other kinds, it has not been found to give altogether satisfactory results for scantlings for railway waggon building (for which karri has been found so good [A.L.H.]). Probably the nature and grain of the wood render it unsuitable."

Jarrah has been used very extensively in England for wood-block pavement with varying results, some being unsurpassed in excellence, while others were somewhat discouraging. The causes for these variations can, however, in most cases be ascertained. Perhaps the most important factor is the question of the pavement foundation, while the time which is allowed for carrying out the work has also some bearing on the result. Unfortunately the laying of pavement is in most cases much too hurried, and probably too little time is allowed both for making a proper foundation and for seeing that this is sufficiently settled before proceeding with the work. It is also doubtful if engineers have even yet specified either sufficient solidity, or enough regularity for the foundation of a hardwood pavement. The force which the jarrah block has to sustain from the heavy weights continually striking the surface, is transferred to the foundation in a quite different manner from that which takes place with a softwood block, which is much more resilient and consequently acts as a kind of buffer. Possibly a medium between the concrete and the block to take this strain would make a considerable difference. As it is, any weakness which develops causes the foundation to give way and brings about the beginning of the " holey " places which characterises hardwood pavements. Immediately one block sinks even a little below the level of those surrounding it, every wheel bumps on the edges and increases the strain enormously, and this again enlarges the area and deepens the hole. Again, if the foundation be carelessly laid, or on account of urgency an insufficient time is allowed for it to set completely, the same trouble ensues. A careful inquiry into the question of foundations for hardwood pavements should be instituted, as there is no doubt that, as the cost of labour is nearly as much for laying the softwood as for the hardwood, a great saving of expense could be assured if this difficulty was overcome. Even in the present circumstances a 5-inch jarrah block pavement has, since 1906, withstood the exceedingly heavy traffic in the Euston Road, London, with fairly good results, and has therefore now (1919) sustained thirteen years of continual use.

Some of these blocks were taken up for repairs this year, and appeared as sound and hard as when they were laid. I had one sawn into 1-inch thicknesses and planed, and not only is the wood in splendid condition, but neither manure nor other deposits which it has had to withstand have impregnated the pores, as is so generally found with softwood blocks after a much less time. Again, the variation of hardness in individual jarrah blocks is much greater than in the case of softwood, so that if only one of the softer kind is surrounded by harder, the same result referred to above occurs. It has been noted that the outer growth of jarrah trees is very much harder and closer than the heart growth, and there is also, of course, a variation in the trees themselves. To guard against this danger it is generally specified that only the harder wood should be used, but in practice sufficient care has not been taken either by the shipper, merchant, or contractor. Probably the most prevalent cause for this, and also for doubtful foundations, is the system of competitive tendering and the endeavour to get work carried out at the lowest cost.

These difficulties have militated against the use of jarrah for block pavement, and it is not so eagerly sought for as it was a few years ago; but considering the cost of labour and the inconveniences of more frequent stoppage of traffic, jarrah pavement should be much more largely used in the future. In 1899 Hornsey Road northward from Shaftesbury Road was paved with samples of jarrah, white oak, creosoted deal, and red gum blocks. The white oak and red gum mostly failed, but the jarrah and creosoted deal were in good condition, practically nothing having been spent in repair, after over six years' traffic.

According to a report of Mr. W. N. Blair, Surveyor for the Borough of St. Pancras:

Park Street was paved with jarrah in June 1893, and in 1907 was in good condition, very little having been spent in repair. Pancras Road, in front of the Town Hall and round into Great College Street, was paved with jarrah in 1892, and, excepting the tramway tracks and margins, was in good condition in 1907, very little having been spent in repair. Mr. Blair speaks of the life of jarrah blocks under very heavy traffic as nearly four years and considers it satisfactory, and also that the life is about 50 per cent longer than that of creosoted deal. In his report he makes this very significant statement, which should receive the very greatest attention of all pavement engineers: "It was not until some of our earliest laid jarrah pavement had worn into holes that the cause of the holes was discerned to be due to the presence of blocks with certain characteristics in their grain, which for several years past we have been rejecting, with the result that more recent work will wear more evenly, and, therefore, will have longer life than the earlier work. . . . The following may be taken as conditions characteristic of the two timbers:

"JARRAH.—Easily cleansed; very durable; good foothold generally; becomes noisy by wear on edges of blocks.

"CREOSOTED DEAL.—Holds the dirt, and becomes greasy; less secure foothold; takes frost readily, therefore slippery; wears evenly, but quickly; more silent under traffic. Exudes an oily film, causing slipperiness, and an unpleasant odour for some time. The effect of creosoting at first reduces porosity, but this protection diminishes." He concludes by saying that all the motor omnibus companies were unanimous in favour of jarrah paving for safe travelling for rubber-tyred vehicles. In a later note in 1914 he thinks that "having regard to their relative prices and life and to certain characteristics attaching to each, such, for instance, as the greater smoothness of surface and as causing less nois under traffic, I think preference must now be given to creosoted deal i it be selected from the most suitable class of timber."

In reference to this last report it is not improbable that the relative costs may change to the advantage of hardwoods and that greater care with foundations and selection of timber may improve the hardwood pavements. For sleepers it is probable that nothing can be obtained which surpasses jarrah for durability and fire resistance, if indeed there is any timber to equal it in this respect. Every year fresh reports come to hand increasing its reputation; its use is therefore specially justified in this country, which, on account of the damp climate, calls for particular consideration, although the termite-proof qualities of the wood are not called into question.

The pores are very large and open and are plugged with gum. The numerous medullary rays can be seen very faintly under the lens.

JARUL. *Lagerstroemia Flos-Reginae*, Retz. Weight, 43 lbs. (Troup). India, Burma, Ceylon.

The wood is of a red-brown colour, with a rather shining surface, caused by specks of bright gum. The grain is straight and even, but not very smooth. Gamble reports it as "The chief timber tree of Assam, Eastern Bengal, and Chittagong, and one of the most important of the trees of Burma. . . . It is very handsome when covered with its large lilac flowers."

This is one of the timbers mentioned in Gamble's list of woods which are available in fairly large quantities and are likely to be worth trial.

The pores are variable in size, and somewhat plugged. The medullary rays are exceedingly small and fine, and are very difficult to identify with the lens (12 ×).

KAKI. *Diospyros Kaki*, Linn., f. Weight, 48 lbs. 10 oz. Japan.

This beautiful decorative wood shares with African blackwood the distinction of being capable of almost the smoothest surface obtainable in any timber; it has a marble-like coldness to the touch. The grain is very close and even, although it is much lighter in weight than any of the other ebonies. The ground colour is a dense black, with beautiful streaks of orange-yellow, grey, brown, or salmon colour imposed upon it; occasionally all these shades are seen together. It is highly valued in Japan, where it is used for ornamental decorative work in boxes, desks and in mosaics. It possesses a slightly disagreeable scent.

The pores are fine and scarce, and are generally plugged. The medullary rays are exceedingly fine, though irregular; they appear in parallel lines.

KARAWE. *Cinnamomum inunctum*, Meissn. Weight, 42 lbs. (Troup). India.

There is no European name for this wood, which has not yet been imported on a commercial basis. Karawe or karaway is the Burmese vernacular name. It has the same general appearance as real camphorwood (*C. Camphora*), with similar black streaks, but it is of an orange-red colour and has a bright sheen. It possesses all the necessary characteristics of a first-rate wood which will stand well under any conditions, without warping or twisting. A few logs were imported some years ago, but as it was unknown it was unnoticed at the time and its undoubted value was quite unrecognised.

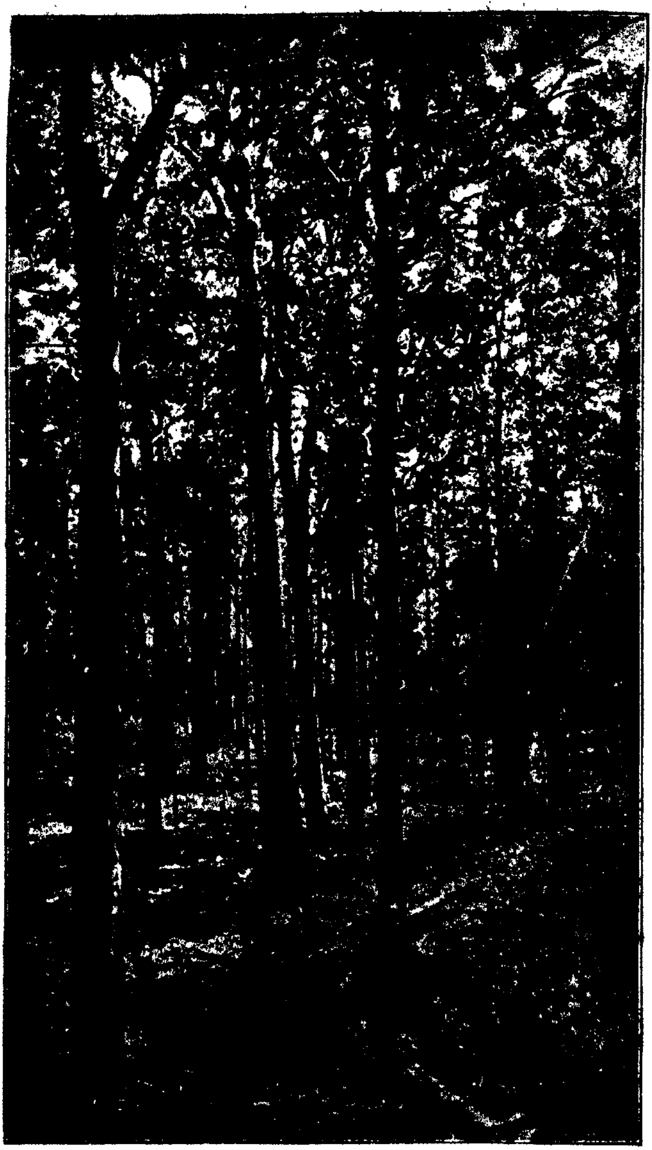
Gamble reports it as being used in India for house-building and for shingles, and Troup speaks of it as being suitable for cabinet-making. It possesses a slight, pleasant aromatic scent which would make it attractive for the linings of cabinets and bedroom furniture. It is altogether a very desirable and useful wood.

The pores, which are not very clearly defined, are irregular in size and are partially plugged with bright, shining gum (?). The medullary rays are rather ill-defined, although regular and clearly apparent. According to Gamble the rays give a good silver grain. This, however, is not seen in my specimen.

KARRI. *Eucalyptus diversicolor*, F. v. M. Weight, 53 lbs. Western Australia.

We are probably only just beginning to realise the value of this important timber, the product of a magnificent tree which grows to an immense height and of which this part of the British Empire possesses such a princely supply. Julius speaks of it as "one of the finest and most graceful trees in the forests of Australia," and as occasionally reaching the wonderful height of "300 feet . . . over 180 feet to the first limb and from 20 to 30 feet in circumference at the base." The timber is red in colour, heavy, tough, dense, elastic, and closely similar to jarrah in appearance. This similarity, however, is actually harmful, and the absence of due investigation and comparison of the two woods has led to the same deplorable results as have been noticed with the Indian timbers, eng and gurjun, which have suffered by their similarity to teak.

Karri is a much stronger wood than jarrah but is not so durable in the ground, and is not termite-proof. It has been largely used in England for railway waggon scantlings and telegraph arms, and has given most satisfactory results; it is doubtful, indeed, whether it has not been proved to be better for these purposes than any other timbers available. For sleepers and paving blocks, however, it has not yet given good results,



A KARRI FOREST.

Photograph by the kind permission of C. E. Lane-Poole, Esq., Forest Department, Perth, Western Australia.

although it is confidently expected that the new process of Powellising, which has proved so satisfactory in Australia, will enhance the reputation of the wood in England. C. E. Lane-Poole says: " It is on Lloyd's list of shipbuilding timbers, and is suitable for all purposes where large sections of great strength are necessary. It has been found very satisfactory for wooden pipes and it makes a good waggon spoke." Julius reports that " Piles of unusual straightness and regular taper, of either ordinary or exceptional lengths, can be obtained with facility and in large quantities, and have been not a little used in water not infested with marine pests. Karri also readily affords baulks of exceptional section and planks of great width."

Although karri has not given satisfactory results when used for sleepers in those countries where the white ant abounds, and perhaps also in our own country in contact with the ground, yet under the Powellising system, a wide prospect of usefulness opens up for this requirement, and perhaps also for wood paving and all those works where the wood has to be in contact with the soil. In regard to its immunity from the attack of the white ant when so processed, there is now abundant proof from many sources in Australia. Numerous good reports come from engineers over a large area, and are the result of experiments made on a large scale. They are also now strongly confirmed by similar reports from India. These are of the utmost importance, in consideration of the future development of the trade in this wood. For the durability of karri in contact with the ground when processed there is not so much evidence yet available, but there is good reason to anticipate that in course of time, and when sufficient trials have been made, the results will prove satisfactory.

Perhaps the most important consideration from our point of view, having in mind its size and abundance, is its employment in fireproof construction, for in a marvellous degree it is able to withstand the ravages of fire, and is therefore of very great value. In a disastrous fire that occurred in the West India Docks, the logs and planks of Australian hardwoods were found afterwards to have received only very slight damage, little more than a thin charring on the outsides.

Logs of this wood should be stored in the water, as otherwise they are liable to split and crack up badly. Planks, boards, and blocks should be stowed entirely under cover, as closely packed as is consistent with a sufficient admission of air to prevent fungus growth or other harm. The place chosen should also be entirely free from sun and rough winds, preferably below the level of the ground and in a slightly damp, rather than very dry, situation.

The pores are large and numerous, and are usually filled with gum. The medullary rays are not discernible even with the lens.

KATSURA. *Cercidiphyllum japonicum*, S. and Z. Weight, 22 lbs. Japan.

A large quantity of this timber has been imported into London and Liverpool during the last few years, in logs, boards, and planks. At first it was not sought for, but its good qualities were soon realised and a considerable demand has since existed. It excels all other such soft and light hardwoods, in its extraordinary smoothness of grain and the sharpness of the edge which can be obtained from either machine or hand tool. This renders it very suitable for mouldings, however intricate the pattern. In these respects it will compare favourably with pencil cedar (*Juniperus virginiana*), which wood, however, can never be obtained in such long lengths and wide widths free from defect. It is of a light nut-brown colour, and is very similar to kauri pine. It has been used for a great many decorative purposes, such as cabinet-making, shop-fitting, and panelling. It has also been largely employed in place of American whitewood (*Liriodendron tulipifera*). While perhaps it does not stand in unfixed work as well as this wood, as it is a little liable to warp if used in widths, it far surpasses it in its very fine, smooth, silky grain and hard surface. It is reported by Goto (*Forestry of Japan*) as being used for wood-engraving in that country.

The pores, which are very fine and obscure, are largely filled with a bright, glistening gum which sparkles on all sections. The medullary rays are hardly visible under a lens (12 ×).

KEYAKI. *Zelkowa acuminata*, Pl. Weight, 39 lbs. 9 oz. Japan.

This is a very handsome, hard, fine-grained, reddish-brown decorative wood, somewhat resembling English elm in colour, but with a much finer quality of texture, which after finishing from the tool displays a bright metallic lustre. It stands well, does not warp or twist, and if imported commercially into the United Kingdom would, when known, make a very handsome timber for decorative purposes, panelling, and furniture. Professor C. S. Sargent (*Forest Flora of Japan*) describes it as Zelkova Keaki, and says: " The wood is more esteemed by the Japanese than that of any of their other trees. It is noted for its toughness, elasticity, and durability, both in the ground and when exposed to the air. It is considered the best building material in Japan, although it has become so scarce and expensive that Keaki is not now used for this purpose except in temples, where the large, light brown, highly polished columns which support the roof are always made of this wood." He also says that it surpasses American oak in " compactness, durability, and lightness; for Keaki, in comparison with its strength, is remarkably light." Elwes and Henry say: " The most beautiful trays and cabinets which come from Japan are made of dark, irregularly-grained and wavy-lined wood of the Zelkova."

The annual layers are very clearly marked, close and numerous; the medullary rays are strong and well defined. The pores are single, very large and open in the spring-wood, but very small and scattered in the autumn growth.

Kingwood. Source unknown. Weight, 75 lbs. 13 oz. South America.

For a number of years the wood which for commercial purposes has been called "kingwood," has been the produce of a number of different varieties which have possessed in a greater or lesser degree the characteristics of the original wood. Holtzapffel speaks of it as being "called violet-wood—imported from the Brazils in trimmed logs from 2 to 3 inches diameter." He calls it one of the most beautiful hardwoods in appearance. Foxworthy says that kingwood or violet-wood is "probably [derived] from species of *Dalbergia* and best known under these names from Madagascar and South America." I have a specimen of sissoo (*Dalbergia Sissoo*) which, although not quite the same, would pass for kingwood. Old cabinets, especially of French manufacture, display a wood which possesses a very transparent surface and a strong metallic sheen. The beautiful effect of the wood when so used can be seen in an English cabinet of the early eighteenth century, which is veneered with kingwood and is exhibited in the South Kensington Museum.

The wood is of a rich violet-brown, shading sometimes almost to black, and streaked with varying lighter and darker markings of golden yellow; it has a bright lustre, and a very smooth surface is obtainable. Always a beautiful cabinet wood, it is still more so when it has become toned with age.

The wood in cross-section shows concentric marking, prevailing dark, and marked by thin, light lines at irregular intervals. The cross pores are large enough to be visible to the naked eye. The medullary rays are invisible, though on very smooth sections a hazy pattern may be seen. The fine light-coloured rays stand out, and are crossed at right angles by similar concentric lines, either single or several close together. With the lens the pores seem to be plugged with a red substance.

Kiri. *Paulownia tomentosa*, Thunb. H. Br., *P. imperialis*, S. and Z. Weight, 20 lbs. Japan.

The wood is extremely light in weight, being scarcely more than half as heavy as poplar. Of a very light nut-brown or reddish-brown colour, it somewhat resembles light-coloured wych elm. In Japan it is used for making musical instruments, bookcases, clogs, and floats for nets. Its charcoal is employed for polishing, and is reported to be indispensable in the manufacture of gunpowder. The Japanese excel in high-class cabinet work, and select this wood in preference to all others for linings and drawers of small cabinets because its shrinkage and swelling are infinitesimal. Such cabinets are not considered to be well made unless the drawers run easily with the slightest pressure, and the pushing in of one drawer causes the opening of another. The wood is very costly in Japan.

The annual rings, marked by the very distinct spring-zone of numerous large pores, are often very wide. Outside this zone the small pores are grouped in short, peripheral lines and thus produce a pattern reminiscent of plum. The pores are all plugged. The medullary rays are fine and just visible or invisible, though in the radial section they stand out as light shallow bands.

KOA. *Acacia Koa.* Weight, 52 lbs. Hawaii.

A few logs of this wood have been imported into Liverpool of late years. They are of good size and length. According to Baterden it is "related botanically to the blackwood of Australia and Tasmania, *A. Melanoxylon*, (and) is the one fairly abundant Hawaiian tree which is valuable for its timber. It is a highly prized cabinet wood a good deal used on the island." It is of a red mahogany colour, capable of a very smooth surface which shows a glossy sheen. The texture is fine and close.

The pores are scarce and regular and show singly and in pairs. The medullary rays are parallel, very fine and rather faint, showing on the tangential section through the lens (12 ×).

KOKAN. *Duabanga sonneratioides*, Ham. Weight, 32 lbs. (Troup). India.

The wood, of which an alternative name is lampatia, is of a light nut-brown colour resembling a pale variety of teak. The grain is straight, but rough and soft, and does not take a nice finish. It is not suitable for requirements in the United Kingdom, and would not repay the expense of shipment.

The pores are rather large and are generally in groups of two or three, with a slight halo of light-coloured tissue surrounding them. The medullary rays are irregular, and rather scarce and coarse.

KOWHAI. *Sophora tetraptera*, Ait. Weight, 48 lbs. New Zealand.

This wood, according to the Board of Agriculture, New Zealand, is pale brown in colour, heavy and compact, and possesses great strength, toughness, and elasticity. It is procurable in short lengths and up to 6 inches in width. It is used for shafts and machinery, agricultural implements, and for cabinet work.

KRANJI. *Dialium indum*, Linn. Weight, 67 lbs. Borneo.

Kranji was mentioned by Laslett as being "imported in 1860–61, and sent to Woolwich Dockyard to be employed for naval purposes. The wood is red in colour, hard, heavy, exceedingly tough, and is one of the strongest with which we are acquainted, every one of the specimens, when tried transversely, taking a very heavy strain. The grain is close and somewhat resembles Cuba or Spanish mahogany, but is very plain. It would take a high polish, and except for the almost total absence of 'figure' to give it beauty, it would be valuable for the manufacture of furniture, or any ornamental purposes."

The wood, however, under the above name, has not been known in commerce in the United Kingdom.

K'RUNTUM. Source unknown. (?) *Helicia* sp. (Foxworthy). Weight, 51 lbs. 13 oz. Borneo.

This is a hard, moderately heavy wood, light brownish-red in colour, and resembling she-oak (*q.v.*). Foxworthy describes the wood as durable and as being used in the building of houses. He tentatively attributes it as a species of *Helicia* (*Proteaceae*). Professor Groom says that although it does recall certain proteaceous woods that have broad medullary rays, it is probable that it is equally possibly derived from a species of *Casuarina*; for it shares with species of this genus the possession of numerous fine (invisible) rays and thin lines of broken tangential (concentric) soft tissue, as well as the remarkable broad rays that often locally divide and become reunited. No distinct annual rings are visible, but very striking are the numerous, very thick, often dividing medullary rays that cover half any surface of the wood and produce the boldest silver grain. The pores being large, by their openness somewhat spoil the appearance of the surface, and often have light coloured contents that cause chalky lines along the grain.

KUREN. *Melia japonica*, Don. Weight, 66 lbs. Formosa.

This is a light-brown, very open-grained timber, which in general appearance resembles wych elm. It is an inferior wood, and is not likely to be useful for anything but the commonest purposes. It has never yet been commercially imported into England.

It has large open pores showing marked gum streaks. Many of these pores appear to wear away, so that the surface becomes irregular.

Kydia calycina, Roxb. Weight, 36 lbs. India, Burma.

The wood is of a whitish-yellow colour, with a straight soft grain; on the radial section it shows the medullary rays in flecks, in a manner resembling beech. Its qualities would not recommend it for export, and it does not appear to be reported on very favourably in India.

The pores, though not large, are numerous. The medullary rays are broad and conspicuous.

LABURNUM. *Laburnum vulgare*, Berchtold and Presl.; *Cytisus Laburnum*, Linn. Weight, 53 lbs. (Elwes). Europe.

A beautiful greenish-brown wood used for turnery, inlay, and cabinet work, laburnum is, in common with many English timbers, hardly ever seen or used. Elwes and Henry describe the colour " when exposed to light, becoming dark olive or red-brown, showing small medullary rays." Sang is quoted " that in his time (1812) it was the most valuable timber grown in Scotland, and . . . sold at 10s. 6d. per foot." It was then used for cabinet-making, musical instruments, handles, and chairs.

Lagerstroemia hypoleuca, Kurz. Weight, 44 lbs. The Andaman Islands.

The wood is of a pale reddish colour showing a minute ripple marking on the radial section. It is hard and durable, and is used in the Andamans for house-building, and spokes and felloes of wheels; as it swells when wet it is unsuited for boat-building. Gamble says that it squares up to 50 feet in length with a siding of 2½ feet. It will be found to be a useful wood in this country when it becomes better known.

The pores vary in size; they are very frequent. The fine medullary rays are distinctly visible.

LALONE. Source unknown. Weight, 69 lbs. Cuba.

In 1892 some hewn logs of about 15 to 18 inches square to which this name was given, were imported into London. The wood is of a red plum-colour, similar in density and texture to Spanish mahogany. It is capable of a fine, smooth surface from the tool.

The pores are scattered and filled with a bright shining gum. The medullary rays are fine, uneven, and somewhat irregular. The tangential surface shows the pores also shining brightly, with minute specks of gum.

LANCEWOOD. *Guatteria virgata*, Dun. Honduras, The West Indies.

The colour of the wood is a pale yellow, resembling a dull satinwood; it has a very close, smooth grain which splits or rends freely. On account of its special elasticity and springiness it is the best timber for shafts for carts. It is also used in a great number of different works, amongst which are bows and measuring rods, though these latter are generally supposed to be made of boxwood.

Lancewood, Moulmein. *Homalium tomentosum*, Bth. Weight, 59 lbs. (Pearson). India, Burma.

Pearson describes this wood as "brown to dark brown, hard, durable, cross-grained, elastic, heavy. The difficulty is in seasoning this valuable timber sufficiently slowly to prevent it splitting. . . . [Its] strength and elasticity render it suitable for shafts of timber carts. Samples of this timber were sent to a well-known firm of fishing-rod manufacturers in England, who reported on it as follows: 'It is a promising wood for fishing rods, but the specimen sent was badly shaken throughout.' Fairly large supplies of this timber can be procured in Chittagong, where the tree is common, and found growing to a large size."

Larch. *Larix europaea*, DC. Weight, 47 lbs. 13 oz. United Kingdom, Europe.

This, one of the most valuable of trees, grows over a vast expanse of country throughout the United Kingdom and the temperate and colder regions of the northern hemisphere. So far as England is concerned, larch was, although growing at our door, despised and little cared for before the war. This is the more remarkable when it is realised that after their occupation of Britain the Romans carried away larch from these shores in order to build with it cathedrals, churches, and houses in their own country.

The colour of the wood varies from a light, bright red to a warm brick colour, always with lighter and darker streaks similar to the well-known marking of pitch pine, to which it bears a strong resemblance. There is a great diversity of thickness in the growth of the concentric layers, which vary according to the climatic conditions under which the tree grows. The annual rings in some cases are very regular, and measure only $\frac{1}{32}$ inch, while in others, of exceedingly wide growth, they increase up to $\frac{3}{4}$ inch or more. This same divergence is also to be observed in individual trees, which range through nearly as great a latitude.

The wood requires care after conversion. To get the best results it should be taken direct from the saw, and carefully stored under cover, with sticks evenly and regularly distributed between the planks. The wood is apt to discolour while fresh, and, more than is the case with ordinary soft timbers, is inclined to warp and twist. It is exceedingly durable under all conditions. Perhaps this quality is best demonstrated in its use in the form of piles, or for wharfing timbers.

It is stated on good authority that the greater number of the houses in Venice are built upon piles of this timber, particularly those of which the supports are alternately exposed to wetting and drying; many of these piles after being in place for ages are said not to have the least appearance of decay. Elwes mentions that "churches and manor houses (in Poland) built 300 to 500 years ago of larch wood are still *standing.*"

A specimen piece of a pile driven in 1854–55 in the river Nene was taken up in 1904, when it was found to be in a perfect state of preservation. Part of the wood was subjected during this period to the action of wind and weather, and alternate wetting and drying. Many notable Italian pictures have been painted on panels of larch. It makes excellent flooring, and if creosoted would be suitable for wood paving, as it is hard enough to resist the wear of traffic, while also giving a good foothold for horses. Used as sleepers larch is superior to other softwoods which can be produced in England, and its greater value in general, compared with them, is shown by the fact that the controlled price of larch during the war was 30 per cent higher than that of any other softwood grown in England. It is one of the most profitable timbers which can be planted in this country, though the prevalence of larch disease has of late years stimulated the planting of Douglas fir in its place. It is to be hoped, however, that as this disease has practically disappeared, larch will again take the premier position which it deserves. A plantation of this wood, when only thirty-nine years old, yielded timber more than 10 inches in diameter at breast height.

Before the war the use of larch was confined to such class of work as park and other fencing, but consequent upon the restricted import of foreign timbers it began to receive honour in its own country, and its utility for a variety of purposes has become widely realised, and its continued demand in preference to other British softwoods proves its value. Amongst other purposes it has taken the place of pitch pine in the framing of bed springs.

The pores are numerous, and vary in size. The medullary rays, invisible to the naked eye, are fine, white, and numerous. The annual rings are very clearly defined, showing the light and dark wood of the spring and autumn growth.

LAUAN. Source unknown. Weight, 41 lbs. Philippine Islands.

The wood is of a pale yellowish-red mahogany colour, much like serayah in appearance but of better grain and texture. It has not been imported except perhaps in very small quantities during the last few years. Father Gaspard of St. Augustine says, in his manuscript History of the Philippine Islands, that the outside planks of the old Manilla and Acapulco galleons were of lauan wood, and that it was chosen because it does not split with shot. According to Foxworthy, who mentions also "White Lauan," "Almon," etc., these are all the product of several species of *shorea* or of *Parashorea plicata* and *Pentacme contorta*, and possibly of *Hopea*. As will be seen elsewhere, the produce of the dipterocarps is much confused, and it is probable that a common name is given to timbers whose source is comprised of many varieties. It is a wood which stands well, is of good quality, and could be used in many important industries.

The pores are uniform and regular. The medullary rays are parallel, but rather irregular.

LAUREL, ALEXANDRIAN. *Calophyllum Inophyllum*, Linn. Weight, 42 lbs. India, Burma, Ceylon.

This is a dark, reddish-brown wood, with a handsome wavy grain. Gamble notes that " the wood is said by Beddome to be ' valuable for some purposes in shipbuilding,' and by Kurz to be ' good for masts, spars, railway sleepers, machinery, etc. . . . It is a magnificent wood for cabinet-makers' work.' " Pearson writes : " The timber is cross-grained, fairly durable, and very elastic, working to a smooth surface and taking a good polish."

This is one of the timbers mentioned by Gamble as being available in fairly large quantities and likely to be worth trial.

The pores are small, and irregular in disposition ; many are plugged. The medullary rays are scarcely visible under the lens. The concentric lines are dark and wavy in pattern.

LEZA WOOD. *Lagerstroemia tomentosa*, Presl. Weight, 50 lbs. (Troup). India, Burma.

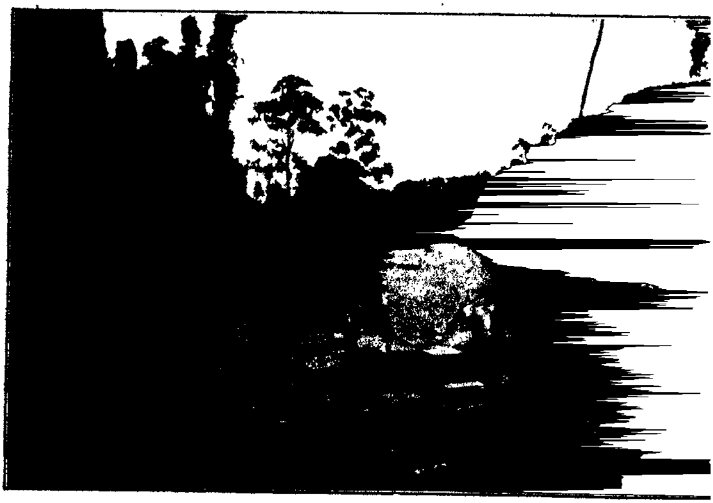
This wood is of a light grey-brown colour and a close, firm, but not very hard texture, and it has a very straight grain, capable of a smooth surface.

The pores are regular and rather small, connected by a network of short, fine, light concentric bands. The medullary rays are exceedingly fine and numerous, parallel and equidistant, and show in a kind of fine ripple ray on the radial and tangential sections.

LIGNUM VITAE. *Guiacum officinale*, Linn., etc. Weight, 88 lbs. 9 oz. The West Indies, Central America.

The commercial supplies of lignum vitae are the produce of more than one species. The best quality, however, is shipped from San Domingo. This is received in lengths of 12 to 18 feet and 8 to 12 inches diameter. From Maracaibo it is imported in lengths of 5 to 12 feet, and from 6 inches to 2 feet in diameter. This variety is very liable to cup shakes. The wood is also imported from Cuba, Jamaica, and the Bahamas.

The lignum vitae received from this last source is that which contains the largest sap-ring. It has been customary to divide all the shipments into two sorts, these being described respectively as " thick sap " and " thin sap." In the former the sap rings vary from anything between one inch to more than two-thirds of the tree, but in the latter generally from not more than half an inch to an inch. The heart-wood is of a greenish-black colour, and upon being exposed to light and air grows darker. The sap-wood is a bright light yellow, in colour very similar to East Indian satinwood. Lignum vitae is one of the hardest and heaviest, as it is one of the most useful of timbers, and for a great many purposes it has been found impossible to produce a substitute. The maintenance of a sufficient store of supply may indeed be said to be a question of national importance, for during the war the great demand practically exhausted all the available supplies. There is nothing equal to it for the making of sheaves for blocks, and when employed in this way it wears well and seems almost imperishable. Laslett said that he had examined some sheaves after they had been in use for fifty to seventy years, and found them perfectly good and fit for further service.



FOREST R

Perhaps the most important of the many uses to which it is put is for the bushing of the stern tubes for propeller shafts in all, even the largest ships. In a private note Mr. S. Woodrow says : " Lignum vitae has been found by long experience to be the best material for this purpose, as, owing to the silky nature of the wood and the oil contained in it acting in conjunction with the water, a natural lubricant is formed."

The life of the material when used in this manner is extraordinary, and varies from three to seven years, the shortest period being the life of the wood for a fast ship like the *Mauretania*. It is also used for making bowls, for which purpose no other wood is so suitable, and for the packings between saws in machine saw frames.

Holtzapffel says that " When first cut it is soft and easily worked, but it becomes much harder on exposure to the air. The wood is cross-grained, covered with a smooth yellow sap-like box, almost as hard as the wood, which is of a dull brownish-green, and contains a large quantity of the gum guiacum, which is extracted for the purposes of medicine. . . . . The fibrous structure of this wood is very remarkable ; the fibres cross each other sometimes as obliquely as at an angle of 30 degrees with the axis, as if one group of the annual layers wound to the right, the next to the left, and so on, but without much apparent exactitude."

THE ANDAMANS.

In the Museum at Kew there is a remarkable specimen of a piece which was taken from a parcel, the whole of which, consisting of many tons, was attacked by a form of rot which spread from the centre to the circumference along the medullary rays in a continuation of perforations, which appeared as though attacked by a worm. The whole parcel was rendered valueless by this extraordinary condition of decay, which, strangely, was confined to the heart-wood and stopped abruptly short of the sap-wood, which was apparently entirely unaffected.

Lignum vitæ was used in the form of marquetry for the decoration of a Dutch table of the late seventeenth century, which is to be seen in the South Kensington Museum.

The pores are exceedingly small and scarce. The medullary rays are hardly visible with the aid of the lens (12 ×). My specimen displays on the transverse grain extending at right angles to the concentric layers, a very pretty marking which has an effect like moiré silk. Nothing can be seen under the lens to explain this appearance.

LILAC TREE. *Syringa vulgaris.* The British Isles.

Mr. E. N. Kent, of Letchmore Heath, has had an auctioneer's or chairman's table hammer made from a lilac tree growing in his grounds. The wood is very firm and hard, and of excellent texture; it much resembles a slightly bleached tulip wood, or the more highly figured and coloured pieces of real camphor-wood. It is rather darker than olive wood, with brighter mauve-coloured streaks, and is altogether a very beautiful medium for inlay or turnery.

The want of general knowledge of native-grown timbers is much to be deplored, and this, in common with many other cases, illustrates how little we know or value them.

LIME. *Tilia cordata,* Miller. Weight, 37 lbs. 8 oz. Europe.

"The wood is very light-coloured, fine and close in the grain, and when properly seasoned it is not liable to split or warp. It is nearly or quite as soft as deal, and is used in the construction of pianofortes, harps, and other musical instruments, and for the cutting-boards for curriers, shoemakers, etc., as it does not draw or bias the knife in any direction of the grain, nor injure its edges; it turns very cleanly" (Holtzapffel).

Limewood is well suited for carving; its smooth and even texture makes it a good medium for this art. A fine example may be seen in the Victoria and Albert Museum, South Kensington, where are two beautifully carved oval plaques of the period of Henri IV., of the late sixteenth or early seventeenth century.

A thin, light concentric band may or may not mark the annual layer of growth. The pores are very small and obscure. The numerous parallel medullary rays are fine and are clearly marked.

LOCUST. (Possibly) *Hymenoe Courbaril,* Linn. Weight, 33–57 lbs. (Stone and Freeman). St. Vincent.

The authentic specimen of a wood of this name in my collection is of a bright colour with lighter streaks, of hard texture and close grain, and resembles many specimens of so-called "satinee" seen in France. It takes a beautiful smooth surface from the tool, and has a glossy, lustrous sheen. In appearance it is quite different from the supposed specimen of the same timber imported from Dutch Guiana which was called either Surinam teak or locust.

The pores are scarce and small, the medullary rays well defined and parallel.

LOGWOOD. *Haematoxylon canapectianum*, Linn. Weight, 50–60 lbs. Central America.

This is only a dye wood, and is not used for timber purposes.

LUMBAYAO. *Tarrietia javanica*, Bl. Weight, 36 lbs. Java, Cochin-China, the Philippines.

This timber was imported into London and Liverpool in 1914 in sawn planks from 10 to 25 feet long, 8 to 14 inches wide, and 1 to 6 inches thick. It is of a light reddish-brown colour, with open pores showing the medullary rays on the surface, as in the plane tree; they are well defined on the transverse grain. Otherwise the appearance and texture is similar to that of East India cedar (*Cedrela*), but it is without any aromatic scent. It is straight-grained and easily worked, but it appears liable to warp and twist, and can only be used as a substitute for cheap mahogany or cedar.

The pores are large and regular, with clearly defined edges. The medullary rays are indistinct and of darker colour than the other growth.

Machilus Blumeai, Hay. Weight, 39 lbs. Formosa.

The wood is of a light brick-red colour, and in this, as well as in its grain and general character, it resembles the plainer and commoner descriptions of mahoganies from the southern districts of America. The grain is firm and straight, and a very smooth surface can be obtained, though the wood shows a liability to warp.

The concentric layers are clearly defined. The pores are very numerous, small, and even-sized. The medullary rays are very fine and sharp and are parallel. They are joined at right angles by a great number of similar lines, which vary greatly in size and strength.

MAGNOLIA. *Magnolia acuminata*, Linn. Weight, 36 lbs. 6 oz. North America.

This tree, a native of America, was introduced into England in 1736 by Peter Collinson, an arboriculturist of Mill Hill. The wood has been imported in square sawn boards of various lengths, thicknesses, and widths, but not on a large scale. If supplies were forthcoming in the future they would be very much welcomed for many useful purposes. The wood is of a creamy-white colour, resembling American maple in appearance, though much softer and lighter in weight. It will take a fine surface from the tool, and has a bright, satiny lustre. A proportion of the trees yield wood with dark purple, black, or blue-black streaks. Where uniformity of colour is required this portion would have to be separated, although the quality of such boards or planks is as good as the creamy-coloured pieces. It would be useful in pianoforte and all kinds of cabinet and joiners' work.

The pores are very small and indistinct, the concentric layers clearly defined, and the fine medullary rays are clear and distinct.

MAHOE, BLUE. *Hibiscus elatus*, Sw. Weight, 48 lbs. Cuba, Central America.

This timber is imported in the form of logs, both hewn square and round, from 8 to 20 feet long, and about 10 to 20 inches square. The supply is small and intermittent. The wood is of a grey-blue colour, sometimes having dark-blue streaks. The character, texture, and grain are similar to Cuba mahogany. It has an agreeable aromatic scent, and when worked the wood has a transparent, lustrous appearance. It is strong, flexible, and elastic, and "does not corrode nails." (Leman, *Hortus Jamaicensis.*) Weisner says that it has all the character of the best European ash, but is more durable and longer in the fibre.

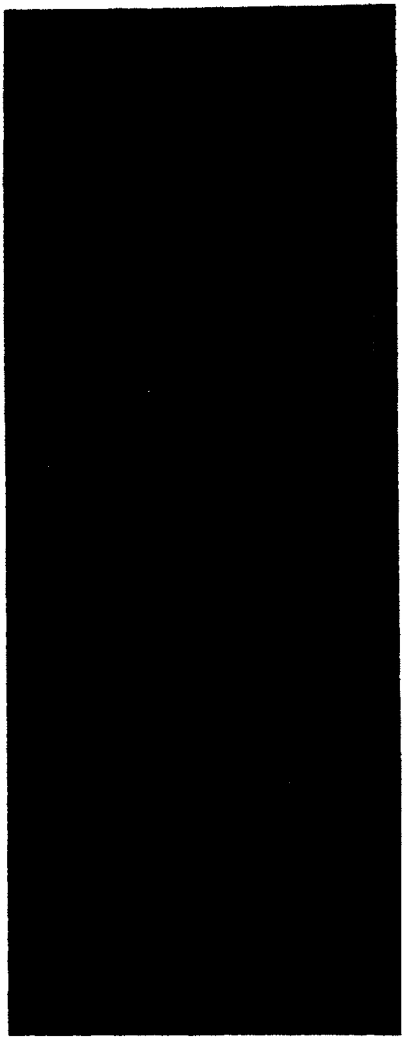
It is surprising that such a beautiful wood should never have been used for decorative work. It combines quality of surface with a very artistic colour, and a room trimmed with it would have the same appearance in shade as genuine harewood (not the artificially coloured so-called harewood), and would be much more lasting and require less delicate treatment. It might also be used for inlay work, and would be excellent for billiard cues. It is very durable when exposed to weather, or in contact with the ground, under both of which conditions the wood seems to harden and improve.

The pores are irregular and rather scarce, and are partially plugged with a bright shining gum. The medullary rays are very clear and distinct, parallel and nearly equidistant.

MAHOGANY. Central America, the West Indies, West Africa.

The name mahogany has been applied, properly and improperly, to many kinds of wood. In judging as to the legitimate use of the name it must be remembered that originally mahogany was obtained solely from the West Indies and subsequently the mainland of America, and that it gained its unique reputation not only because of its decorative qualities, such as colour, figure, lustre, and capability of taking a high polish, but also because of its mechanical characteristics, which include relative hardness, remarkably slight shrinkage so that the wood stands well, and also because of its considerable powers of repelling the attacks of beetles responsible for "worm-holes." Therefore, to give the name mahogany to other woods that are merely reminiscent of it as regards colour and general appearance is quite unjustifiable. Yet the name has locally or even more widely been applied to numbers of woods having little agreement with mahogany in appearance or properties: for instance, in Australia, the woods of several kinds of gum trees (*Eucalyptus*), including jarrah, and in the United States even a common birch (*Betula lenta*).

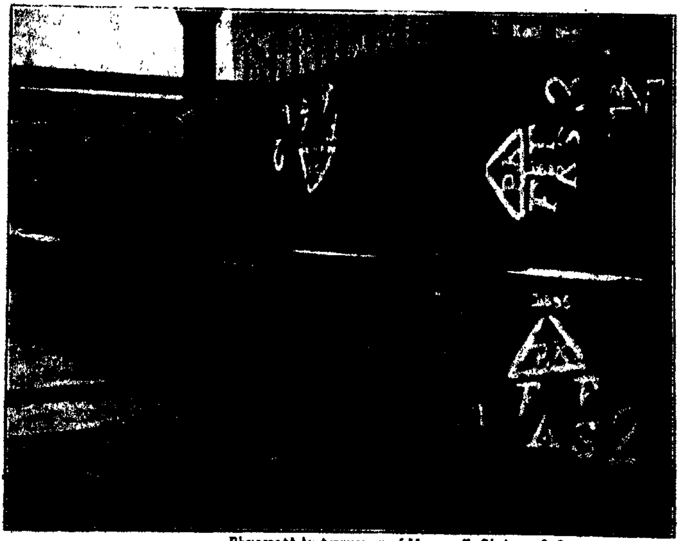
The woods deserving the name of mahogany are now procured from Central America, the West Indies, and tropical West Africa. The American woods are said to be the products of a genus *Swietenia* which belongs to the family Meliaceae, which might be termed the mahogany family. The Swietenia trees themselves have leaves recalling those of ash or laburnum in design, though not in shape. The flowers, seed-cases, and seeds are also characteristic. The genuine African mahogany tree would be recognised as such by persons familiar with *Swietenia*, for in foliage, flowers, seed-cases and seeds, as well as in wood, they closely resemble the American trees. They belong to the same family, Meliaceae, and even to the same subdivision of that family, but to different genera, namely, in the main,



A very Handsome African Mahogany Curl

Khaya and *Entandrophragma*.[1] To distinguish between these genera and *Swietenia* requires the trained eye and experience of a botanist; indeed so close is the resemblance that the botanist first describing an African species of the *Entandrophragma* named it *Swietenia angolense.*

The mahoganies of America differ among themselves, and from the African mahoganies, yet certain American and African kinds agree so closely that even experienced practical men often find it difficult, if not impossible, to distinguish between them. As a matter of fact, however, it is possible for the expert, especially when aided by the lens, to recognise the American or African source of any sample. So far, then, the woods of both continents are entitled to the name mahogany.



Photograph by permission of Messrs. E. Chaloner & Co., Liverpool.

AFRICAN MAHOGANY. TWO FINE FIGURED LOGS.

Other genera of the same family, Meliaceae, provide woods more or less closely agreeing with mahogany, for instance: *Carapa* in Africa and America, *Disoxylum fraserianum*, the Australian mahogany or pencil cedar, *Soymida febrifuga*, the red-wood or mahogany of India. Other members of the Meliaceae supply so-called mahoganies or cedar-wood: such are species of *Guarea* or *Pseudocedrela* in Africa (for instance, Sapeli mahogany is truly a scented cedar-wood derived from a *Pseudocedrela*).[1] The meliaceous *Cedrela* is the source of cedar-woods in tropical America and Asia, and in Australia. Farther removed from mahogany are still other woods yielded by members of the same family: namely the Chittagong wood (*Chickrassia*) of India, and East Indian satinwood (*Chloroxylon*). It is therefore evident that the woods of only certain members of the Meliaceae deserve the name mahogany.

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[1] According to H. N. Thompson.

MAHOGANY, AFRICAN.—Tropical Africa now supplies the greater part of the enormous quantity of mahogany which of late years has been imported into England. It is a wood of such beautiful appearance and fine qualities that it has found a ready market, and has indeed been employed all over the civilised world. The total imports into Liverpool alone, during 1913, amounted to 64,579 logs, out of which 33 million feet were sold in Liverpool; apart from this, 20,000 odd logs were transhipped. To this has to be added over 21,000 tons, approximately over 10 million feet, imported into London, making the total for London and Liverpool amount to over 43 million feet.

The increase to Liverpool is shown as follows:

	Million Feet.		Million Feet.
1894	9	1903	21
1897	13	1905	17
1900	18	1913	33

Perhaps it is hardly realised from what a vast area these supplies are obtained. From Senegal to the present known limit in Angola, the timber is available throughout a country extending along a coast-line of approximately 5000 miles, and from nearly 10 degrees south of the equator to nearly 15 degrees north. Having this in mind, very much more emphasis should be laid upon the names of the districts whence the timber is obtained, and which to some extent regulate its character. No one would confuse, for instance, the produce of Honduras with that of Cuba. Yet in practice, as far as the public is concerned, the supplies from this immense tract of country are grouped together under the one inclusive term of "African mahogany." In some specifications the terms "Lagos" or "Benin" are used, but in many more cases no such precise designation is found. Yet the distinction in character and quality is very great, and in tendering for a supply which merely stipulates "African mahogany," a wide field is open for conjecture as to what class and how far down in the scale of quality the buyer will accept.

One of the advantages of these African supplies is that they furnish an abundance of wood of greater length and width than any other kind of mahogany. The greatest fault is the prevalence of heart-shakes, cross-breaks, wind-shakes, and thunder-shakes, which are the various names given to cross fractures. These are liable to occur at intervals ranging from 6 inches to 10 feet apart, and extend across the longitudinal grain more or less extensively, so that actually in some cases the log *has broken in half. In all cases these fractures mar the appearance and scope of the timber, and occasionally render it entirely valueless.* Much speculation has arisen as to the cause of this defect. Some have

FELLING A LARGE BUTTRESSED MAHOGANY TREE IN WEST AFRICA.

said that it is caused by lightning or thunder, hence one of the names; but the general opinion is that it is caused by the swaying of the trees to and fro in the wind. I do not, however, agree with this theory, nor do I see how it can be sustained. In logs of close, firm texture from circumference to heart the defect is little found, but in those trees where the heart-wood is soft and spongy, or, as it is termed in America, " punky," the cross-breaks abound. In these trees the annual layers or rings are much closer and compact in later life, so that the portion of the tree which is likely to be cross-broken can often be very nearly estimated by the expert from the appearance of the butt, which will show approximately the point where the tree began to make slow growth. In such case the difference between the strength of the outer and inner layers must be very considerable. It seems, therefore, quite possible that in later life the inner portion dries up and shrinks, and, being bound in by the close, strong outer layers, a strain is caused which snaps the fibres of the soft and weaker parts. This theory is supported by an observation of other varieties, where the heart-wood is found to be more regular, and almost, if not quite, as strong and compact as the outer wood, and in which heart-breaks are rarely found. Whatever the reason may be, this fault has caused many a disappointment to the over-sanguine purchaser, who finds his £500 log stricken with this complaint. There is no doubt that the figured wood is more liable to the defect than the mild, straight-grained plain logs.

The varieties known as " Sapeli " and " cherry " mahogany are not liable to soft hearts, as the character of the annual layers is uniform throughout the life of the tree, and in these kinds cross-breaks are rarely found.

It has now been seen that of the several varieties of mahoganies and other hard-woods shipped from the different ports on the West Coast, the larger proportion are offered and sold under the general term " African mahogany." Many of these are not true mahoganies, and others, though bearing some resemblance, yet vary to such an extent that the difference is easily recognisable. Those shipments which are recognised by the trade as being true mahogany are the varieties which are now to be described.

Benin. Weight, 38 lbs. 9 oz.—This mahogany must now be considered the best obtainable from the coast. Benin, Grand Bassam, and Lagos wood most nearly resemble the supplies from Honduras. The colour is the true bright mahogany-red, though slightly browner than other varieties; the wood works well under either hand or machine plane, for it possesses the quality which is termed " a good bottom." It stands well without shrinking, warping, or twisting, and the large sizes in which it can be obtained add to its value. It is especially good for panels, for which it is superior to most other mahoganies. The grain, although not liable to twist or buckle, is more tough and interwoven, which renders it less liable to split or fly in pinning. The more figured wood, which is unsuitable for panels, proves attractive for decorative work on account of its colour and the variety of the grain. The logs, which are of solid, firm growth, are generally free from cross-breaks, and yield a large percentage of clean, sound wood of a reliable character. There is little doubt that this timber would yield as good material for aeroplane propellers as anything that could be obtained. Indeed, African mahogany of Benin quality was found to have been used in the propeller-blades of the Zeppelins brought down in England during the war (1916).

The pores are rather small but exceedingly numerous, and many are plugged. The numerous pronounced medullary rays are wavy and form a pretty ripple marking on the radial section. Rather indistinct concentric lines cross the rays at irregular intervals.

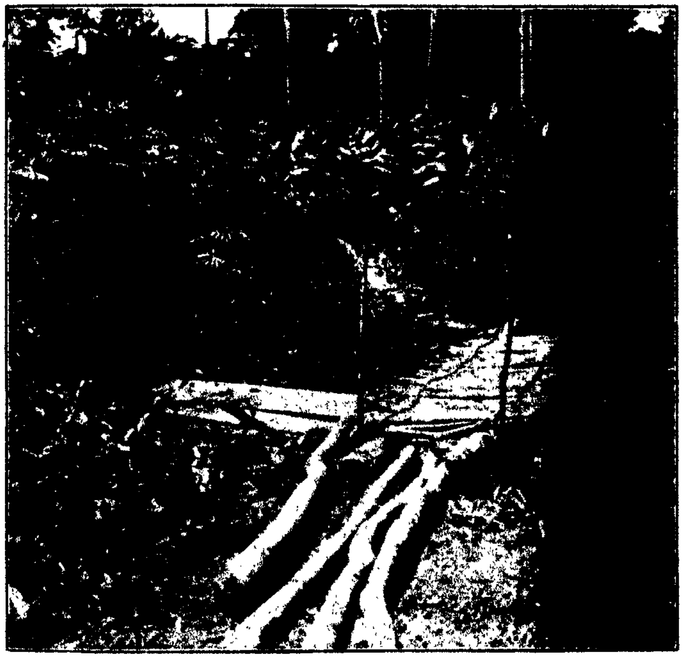
LAGOS. Weight, 31 lbs. 15 oz.—The timber shipped from this port held the first place for quality for a long time. Since 1892 the shipments have contained a large proportion of finely figured timber of a beautiful, bright clean quality, a standard which has not been maintained in the later deliveries. The former kinds are now more rarely seen, and although there is still a certain quantity of good wood being imported, it is doubtful whether the supplies now occupy even a second place in the shipments from the West Coast of Africa. The logs are well squared and manufactured, but a large proportion now contain soft hearts, which have a greater prevalence of cross-breaks: the logs have weathered badly and display side-shakes and splits. This may be due to the timber being felled and shipped at the wrong season, as I am informed that felling proceeds throughout the year. In colour and quality it is very similar to the Honduras wood, and it is often difficult, if not impossible, to distinguish between them. A little more care would be required in selecting this timber for aircraft propellers than would be the case with the Benin wood.

The medullary rays are even more pronounced than in Benin mahogany, and the pores are slightly larger and more open; in all other respects it is similar.

GRAND BASSAM. Weight, 31 lbs. 15 oz.—Shipments from this port have greatly increased during the last few years, and the quality has much improved. The average sizes are exceptionally large and long, ranging up to 30 feet in length, and often 4 feet square, while even larger sizes are sometimes obtained. A large proportion of the trees yield richly figured logs, and many fine specimens have been seen of recent years. Amongst these was a tree shipped to Mr. J. J. Richardson, of which three pieces were sold in Liverpool and one in London: these four realised the record price of £4228. The butt cut of this tree contained about 5000 feet of measure, that is, 417 cubic feet, and weighed

9½ tons. It required two days for 300 men to haul this log to the river for shipment, and the one piece was sold for £2518.

The timber from Grand Bassam is generally shipped with a larger amount of wane on the sides than is the case with other African mahoganies. This is an economical way of manufacturing the timber, but causes a considerable loss. Not only does the heavy wane reduce the width obtainable in conversion, but it is measured almost as if it were square, and the sawing bill has to be paid for the widest part of the log. An additional loss is also experienced, as the outside of the log generally carries about an inch of sap and has a large number of small worm-holes. This timber would probably yield a greater proportion suitable for use in propellers for aircraft than anything else except Benin.



AFRICAN MAHOGANY. A PATH THROUGH THE FOREST.

In structure it resembles the Benin wood, except that the pores are slightly larger.

SASSANDRA. Weight, 27 lbs. 9 oz.—This wood is harder, closer in the grain, and of a darker colour than any other African mahogany except

Bathurst. A certain number of logs coming from other districts, and especially from Axim, are of the same variety as what is generally known as Sassandra wood. Nearly all these logs contain dark gum veins which are more or less pronounced. The surface of the wood when planed is very smooth and lustrous, but it is liable to crack and will sometimes split in parallel longitudinal lines. Some very finely figured logs have been seen which realised exceptionally high prices; one log was sold for over 10s. per foot superficial of one inch, which is equal to £6 per cubic foot. As these figured logs, however, are always required for veneers, and Sassandra wood has been found to crack when converted, it is not now very favourably received. This variety was also found in the propeller-blades of the destroyed Zeppelins. It is probably the best kind of wood for this purpose, especially if used in alternate layers with cherry mahogany.

BATHURST. Weight, 48 lbs.—Between the years 1894 and 1897 some of the finest mahogany which has been seen from the West Coast of Africa arrived from this port. The shipments then suddenly ceased, and this class of mahogany has not since been seen. During the year 1913 a small shipment was sold in Liverpool which was catalogued as having been shipped from Bathurst, but the quality was not comparable with the original supply, or even at all similar to it. For firmness of grain and texture, richness of colour and depth of quality, even good specimens of Cuba and San Domingo would not surpass it. Slightly heavier than these in weight, it was of a rich, red-brown colour, and a few logs were obtained large enough to yield 28 inches, or even a little more, cut clear of the heart, which contained the richest broken roe and mottle.

The pores are very large and are sparse. The medullary rays, which are exceptionally thick, are parallel and irregular.

ASSINEE. Weight, 28 lbs. 9 oz.—Supplies of mahogany from Assinee are remarkable on account of the extraordinary number of finely figured trees which are obtained, many of which have realised almost fabulous prices. Except in this respect, the wood is not on the whole so satisfactory as the other kinds. In general character it is softer and lighter in weight, and the defect of cross-breaks is perhaps found in Assinee wood to the greatest extent of any, many large trees being entirely spoilt by this fault. There is a noticeable scarcity of mild, straight-grained wood, and a large proportion is of a poor colour.

The pores are less abundant and more scattered than in the Lagos wood, but in other respects it is similar.

AXIM. Weight, 30 lbs. 1 oz.—This quality is rather mixed; a considerable proportion yields bright, excellently coloured wood of good texture, some of which is as fine as the best of any sorts, while on the other hand there is a certain amount of defective, soft, punky wood containing cross-breaks. The logs suffer badly on account of the necessity of shipping them in the surf of the sea over a rocky coast, which rubs the sides so that they present a torn and bruised appearance, while the fact that they are usually shipped in short lengths is a further disadvantage.

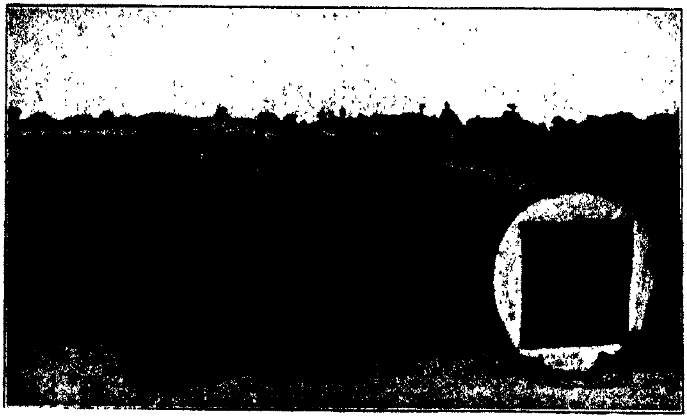
AFRICAN MAHOGANY. A RAFT ON THE RIVER.

The numerous pores vary largely both in size and position; some are plugged. The medullary rays are fine but very distinct, and show in small flecks on the radial section.

SECONDI. Weight, 47 lbs. 13 oz.—This wood is generally harder and heavier than the other varieties. A proportion is sufficiently hard to be a good imitation of the Cuba wood, but there is an absence of the white chalk marks in the grain. The logs are shipped well squared, but are liable to splits and to side and end shakes. The quality of the wood makes it more suitable for decorative work and furniture than for panels, especially as the rich red colour is very good. A large percentage, if not all, of this wood should be quite suitable for aircraft propeller-blades.

The annual layers of growth are well defined ; the pores are decidedly less numerous, and the irregular and broken medullary rays are less distinct than in the Benin wood. The radial section shows bright shining gum in the small pores.

WARRI. Weight, 38 lbs. 9 oz.—This is a very hard timber with a grain which is often much interwoven and is of a roey character. The colour is a light reddish-yellow which darkens slightly on exposure to the air. The logs are liable to star-shake in the heart, and generally show a good deal of fault on conversion. It is a useful timber for decorative fittings, and if properly finished (not french polished) the appearance is pleasing and unusual. It would undoubtedly be suitable for use for aeroplane propellers.



MAHOGANY. SHOWING WASTE IN SQUARING TIMBER.

The pores are very regular in size, and are often filled with gum. The medullary rays are strong, irregular, and not equidistant ; they are joined at right angles with similar white lines. The tangential grain shows bright spots and streaks of shining gum, and there is a slight, pleasantly aromatic scent, somewhat resembling that of African cedar.

CHERRY. Weight, 40 lbs. 12 oz.—There is no distinctive name by

A Mahogany Camp in Southern Nigeria.

which this variety can be recognised. The name "Cherry" is one given by Americans on account of its colour, which somewhat resembles that of the American cherry wood. Although specimens have been found among the mahogany imports from nearly all the ports on the coast, the largest quantity has been imported from Lagos and Cape Lopez. The logs are of the usual dimensions of the African mahoganies, and range up to 6 feet in diameter in round trees and 50 to 56 inches square in the hewn logs. The wood is hard, strong, comparatively heavy, has a close texture, and is liable to warp and twist if used in an unseasoned condition, though it stands well if properly seasoned. It varies considerably in colour, part being of a light mahogany red, while some is a very dull brown; the finest, a warm, bright red, closely resembles the matured colour which is assumed by the Cuban or Spanish woods. The logs are inclined to split on the ends and sides, and do not weather so well as the ordinary sorts. The splits also generally extend throughout the length of the whole piece, and recur at intervals of a few inches over the hewn or sawn surface of the outside of the log in parallel lines. This wood should therefore be converted into planks, boards, scantlings, or veneers immediately on arrival. It is exceedingly difficult to cut with the saw on account of a kind of gum which it contains, which clogs the saw and blunts the tool. An ordinary bandsaw such as is used in Europe will not, however ingeniously prepared, enter the wood beyond a few inches. The majority of the logs are also impossible to saw with either veneer or ground-off saws. A horizontal reciprocating saw specially set and prepared can be used successfully if a continuous stream of soapy water is poured on it as it is working. Without these preparations the saw will run and produce irregular thicknesses, or parts of the board will have the grain torn out, and the saw will generally be jammed so that it is only extracted with the greatest difficulty. To the inexperienced eye this is the more surprising as the appearance of the timber would give the impression that it is the easiest kind of African mahogany to saw. These disadvantages militate against its use, although when they are overcome it provides a valuable cabinet, furniture, and decorative wood, especially suited for counter-tops, hand-rails, and chair wood. Many of the logs are richly figured. Some of them retain their first brilliant appearance, and will provide panels quite equal in effect, if not occasionally superior, to that produced by the Cuban wood. Sometimes, however, the figure sinks or dulls somewhat after polishing, and does not show brilliantly except under particularly strong natural or artificial lighting. The surface is much spoilt by the french polishing which is customary in England. The American and Continental custom of using a coach-maker's flat varnish is preferable. This variety of African mahogany was found in the propeller-blades of the destroyed Zeppelins. It was used in alternate layers with ordinary African mahogany, or Honduras or Sapeli. The Germans seemed to consider that it was immaterial which of the three was used, but evidently the cherry mahogany was purposely introduced on account of its strength and reliability.

FELLING AND SQUARING AFRICAN MAHOGANY.

The pores are small and are generally filled with a bright gum ; the medullary rays are fine and parallel, occasionally showing slightly on the radial section.

SAPELI. Source unknown. (A species of *Entandrophragma* ?)[1] Weight, 44 lbs. 1 oz.—A very large quantity has been imported into

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[1] Mr. J. M. Hillier, *Kew Bulletin* No. 2, 1913, p. 82.

Liverpool and London since the general introduction of West Coast wood. The logs are of unusually large size and length, even up to as much as 7 feet square. The principal deliveries have come from Lagos and Benin, but this variety is found in the supplies from all the ports, and especially in the so-called "Bonamba" mahogany imported from Duala. It has been customary to name this wood Sapeli mahogany when it was imported from Lagos and Benin, but if received from other ports it is described and sold as mahogany without special classification, excepting that occasionally the timber is called "scented." A few logs possess very strong characteristics of cedar, with its pungent aromatic scent; others have only a faint scent and a corresponding absence of cedar texture, while a few have cedar characteristics and scent on one side of the tree, while being the pure mahogany type on the other side, which is devoid of any scent. The wood is generally heavier and harder than the African mahogany, and almost invariably contains a roey or contrary parallel grain, which is often broken in character and interspersed with more or less strongly pronounced mottle. These logs produce very handsome figured and coloured wood, which is used either in veneer, or solid for panels or other decorative work. A straight-grained log is very rare. The principal fault consists in its liability to splits, which are generally ring or cup-shakes following the line of the concentric layers. These show as actual splits on the butt end of the tree, but they are also liable to develop along a gum streak after the wood is sawn up, and, unlike the other kinds of African mahogany, generally extend throughout the length of the tree, occasionally repeating in circular layers at intervals of a few inches. Another of the disadvantages of this wood is that after finishing and polishing the soft grain will sink slightly and the hard grain will rise, showing rather an uneven surface. This difficulty can, however, be overcome by careful finishing. The wood is almost entirely free from cross-breaks, so prevalent in all other West Coast varieties. The general colour of the timber is much browner than the other mahoganies, and on this account the use of the ordinary wood has been condemned in America, where the practice of sawing up different logs and mixing the produce results in a variety of colour in individual boards. There also the finely figured logs are not liked for veneers on account of their liability, due to the exceedingly hot, dry climate, to split badly after conversion. Before the war the principal demand was from Germany, where this wood seemed to be very favourably received, as it was well suited to the design of decorative cabinet work peculiar to that country. Sapeli mahogany was found in the propeller-blades of the destroyed Zeppelins, and is undoubtedly a very fine material for such work.

The pores are rather large and irregular, and are interspersed with

African Mahogany. Adzing Square.

bands of smaller pores which make a wavy pattern somewhat as in elm. The medullary rays are strongly marked and are parallel; they show on the radial grain as in maple.

JAMESON RIVER. Weight, 40 lbs. 12 oz.—Most of the timber shipped from this source is of a lighter colour and closer grain than any of the other kinds. A larger proportion of the wood is of a very pronounced cedar character and some is scented. The logs are sound, and the wood is of a good, firm, useful texture.

GABOON. *Boswellia Klaineana.* Weight, 25 lbs.—This extremely useful wood deserves a name of its own, since it certainly fills a place of importance which justifies a title which would give it individuality, though it should not be called mahogany. This fact is recognised on the Continent, where it is known by the name of Okumé. Although used for many of the purposes for which mahogany is required, it is certainly not considered a mahogany.

Pale in colour, soft and light in weight, and yet strong, it meets the special requirements of many classes of work, and at the price at which it has been obtainable for a long period it probably provides the best value for money of any known timber. By some authorities it has been claimed that it is a cedar, but there is no evidence to support this assumption, and the scent of cedar is entirely absent. For the making of cigar-boxes, however, so long as cigar manufacturers paste nearly, if not actually the whole of their boxes over with paper labels, this wood should prove equally suitable. It is largely used in automobile carriage construction both in England and abroad, and also for ship's fittings, and on the Clyde and elsewhere it has superseded pine for this purpose. Its appearance is much improved by either a light carriage varnish or polish, without the use of stain; french polish or stain generally causes a muddy, and therefore an unsatisfactory, surface. One of the handsomest show-windows in a large store in New York is furnished with finely figured wood of this species, which, besides looking very bright and showy, makes an excellent background for the display of wares of all sorts. It needs a good finish, when it will present a very fine appearance. Gaboon has been tried for the purpose of making aeroplane propellers, but has been found to be entirely unsuitable.

The transverse grain shows that it has great similarity to Honduras mahogany, although the marked appearance of the annual layers is absent; the pores are irregular, as in Honduras; the medullary rays are strongly marked, and are parallel but not equidistant.

CAPE LOPEZ. Weight, 38 lbs. 9 oz.—Logs from this port consist of excellent wood which is generally mild in quality and straight in grain;

it is of a bright colour and is easy to work. This mahogany is one of the most valuable woods which come from the coast, and is specially suitable for panels ; unfortunately the logs arrive badly star-shaken in the heart, or contain other shakes or splits, which would suggest that they are either felled carelessly or suffer damage in transit. It is possible that this may be caused by the logs being hurled by the currents against rocks in their passage down the rivers to the sea coast. They are also more or less damaged by teredo worm-borings. Worm-holes, either of large or small size, on the outside of logs from other ports, do not generally prove to be a serious matter, as they rarely penetrate far. In the Cape Lopez wood it is quite different, for the boring of the teredo worm is found to penetrate into the entire log, sometimes even reducing it to a mere honeycomb so that it is of little value. It is not possible always to see the indications on the outside of the log, and even a careful search will fail to disclose the slightest sign of the damage, which is only discovered after it is sawn up. On one occasion such a log was found to contain many hundreds of these teredo worms alive and hard at work. The sawyer obtained some and left them in the mill overnight, but by next morning they had been devoured by rats. He afterwards secured alive a worm measuring 22 inches in length, and upwards of ¾ inch in diameter, which is now preserved in spirits of wine. The piece of the log from which it was taken contains the end of the hole which has been bored, and which measures exactly ⅞ inch in the largest part. One board 6 feet long by 20 inches wide contained over 70 of these holes, many of which were more than ¾ inch in diameter. The worms work surrounded by a slimy solution which probably acts as a lubricant to the teeth or jaw, working like a tool commonly employed in a centre-bit. The hole made in this manner is at first bright and clean, as cut by an ordinary tool, but after the body of the worm, surrounded by solution, has passed through, it is left as though polished, with an almost black covering. The body of the teredo worm which was found was full of sawdust. It is desirable that this damage should be stopped. Many people would be glad to have an opportunity of using Cape Lopez wood, but are unable to do so on account of this fault. The quality of the timber is so good that it would well repay the extra price which would be obtained, whatever expenditure was necessary.

A large quantity of Gaboon mahogany or "Okumé" (*Boswellia Klaineana*) has also been imported from Cape Lopez. Whether this timber comes from the same district as the ordinary Cape Lopez wood, or is transhipped from another port, is unknown, but it is certain that the wood is identical with that which is known as Gaboon. The general quality has been better than that shipped from Gaboon itself, and the logs have been more sound and serviceable, but the claim that it is different in character is incorrect. There is a slight variation in both supplies, a proportion of the logs from both ports being of a slightly different character and quality, as well as of a superior texture. This, however, is only a variation without distinctive difference. For a fuller description reference should be made to the account of Gaboon mahogany.

The appearance of the tangential grain of regular Cape Lopez mahogany (not Okumé) resembles that of Grand Lahou, but the average weight is less. The pores are scattered and scanty. There is a light, ill-defined concentric ring, which may or may not mark the annual growth. The medullary rays are very fine and parallel; they are rather indistinct, and are joined at right angles by similar white lines of parenchyma: all these characteristics are very similar to the Grand Lahou wood.

GRAND LAHOU. Weight, 30 lbs. 12 oz.—This timber is very similar to Lagos, but the logs in general are not so sound or so good in quality. When carefully selected this wood makes excellent panels. The ports of Twin Rivers, Benin River, and others yield similar supplies to the above, but are generally more varied in character and quality.

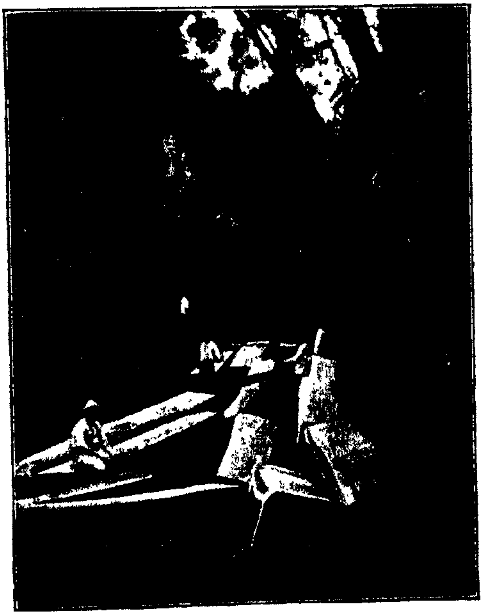
The medullary rays are rather indistinct and irregular; the pores are scattered and irregular in size and position; the concentric layers are indistinct.

BONAMBA. Weight, 35 lbs. 4 oz.—Of recent years a large quantity of timber has been imported almost entirely in round logs, but a few have arrived hewn square. The shippers have sent a miscellaneous collection of all kinds of timbers without discrimination. These are found to consist of about eight widely different varieties, several of which in no way resemble mahogany. Great difficulty has been experienced in selecting the logs of true mahogany before the timber has been sawn, as it is all covered with discolouring matter. It is evident that all the trees of the forest have been cut without any selection, but the experiment must have been found very unprofitable, as the uncertainty regarding the nature of the wood has been reflected in the exceedingly low prices realised for the shipments.

The true mahogany which is found is of fine quality, colour, and texture, is generally straight-grained, and mild, and is suitable for panels. Among the unknown varieties of logs some develop a blue mould which clings to the outer skin on the circumference and on the ends of the logs, and produces after sawing a white mould or fungus which fills all the pores, and the wood appears to possess no virtue or strength and becomes quite valueless. Some of the logs are perforated with worm-holes. Another variety is similar to the description known as Sapeli, and is almost indistinguishable from it. Still another kind produces a wood of a dark dull brown colour, with a closer texture and a harder grain; this, though quite unlike mahogany, is useful as it is suitable for many kinds of cabinet work, and especially for counter-tops.

The transverse grain of true mahogany is generally similar to that of Benin but has slightly larger pores; the colour is a deeper red and the medullary rays are less distinct.

Mahogany is also shipped from the following ports: Coco Beach, Echinda, Princes, Acquidad, Pontadoon, Dixcove, Forcados, Duala, Degama, Beniot, Fresco, Ovenda, Quillo, Boutry, Mundah River, Trepow, Beyin, Sinoe. These, however, are in general similar to the foregoing varieties.



MAHOGANY. LOGS BEING PREPARED FOR HAULING AND SHIPPING.

MAHOGANY, COLOMBIAN. *Cariniana pyriformis.* Weight, 42 lbs. Colombia (South America).

The name mahogany is incorrectly applied to this wood, for it does not belong to the mahogany family. The timber, however, is so similar that commercially the name will probably continue on account of its suitability.

The supplies are shipped from Cartagena, a port on the Atlantic coast of the State of Colombia. Formerly they were only imported to Havre, but latterly London and Liverpool have received supplies. The logs are mostly in the round, but occasionally are hewn with waney edges, in large squares, ranging from 18 to 48 inches. The wood is always very much split and damaged, which is possibly due to the logs being dashed with some force against rocks or other obstacles in their journey down the rivers to the coast, for they are usually cut from one to two hundred miles inland. As has been said, the timber greatly resembles mahogany in colour and is often beautifully figured. It works well, takes polish readily, and when well seasoned neither shrinks, warps, nor cracks.

The wood can be distinguished from genuine mahogany by the numerous thin, light lines joining the rays at right angles, and thus forming a close network with rectangular meshes.

MAHOGANY, COSTA RICA. Weight, 42 lbs. 15 oz. Costa Rica.

The timber from this zone is imported in straight, short, hewn square logs of about 8 to 20 feet and over; they are generally short in length and are 10 to 30 inches square. It is of a bright red colour, has a firm texture, and is hard and close-grained; the pores are often filled with a white chalky substance. In character it is like the Cuban wood, but is generally more straight-grained. The logs are very liable to heart-shakes and galls, while rotten and defective places, in which burrowing worms are found, are prevalent.

The uses are the same as those of the Cuban wood.

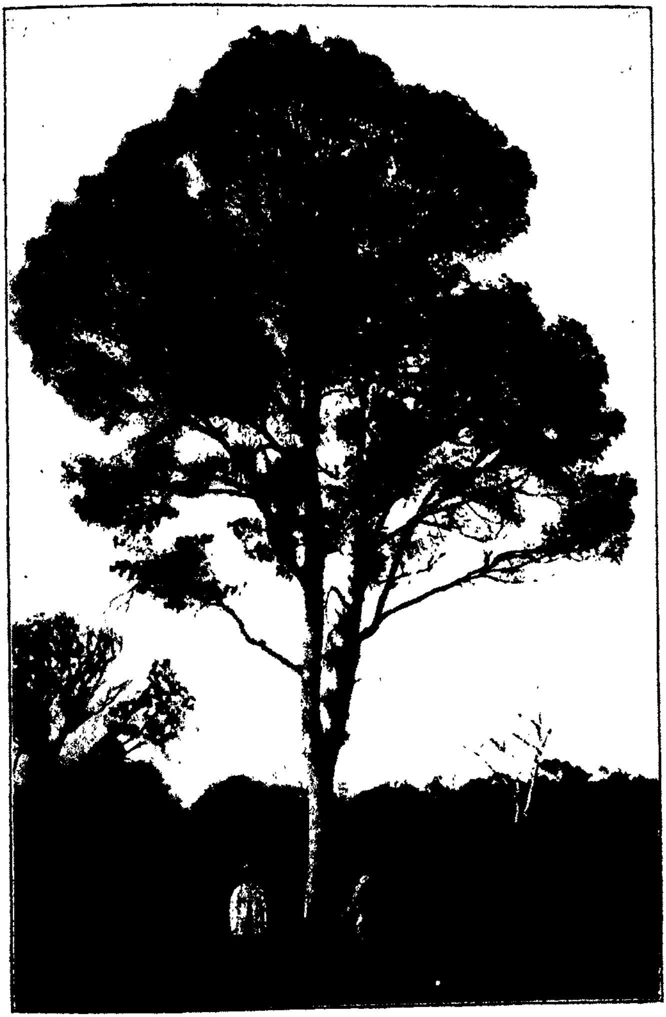
MAHOGANY, CUBA. Weight, 39 lbs. 11 oz. Cuba.

This is imported in round logs with the bark on, also in hewn square logs which are mostly straight, though some are bent and crooked, and in sawn boards and planks. The logs are from 8 to 36 inches square, and from 6 to 30 feet in length, though some are considerably larger. The imported sawn timber is of small size and indifferent quality.

The wood is generally of a hard, close texture, and is heavier than any other mahogany except some of the Spanish wood. When first cut it is of a light-red colour, but on exposure it rapidly darkens to a rich deep red, which, with its glossy, transparent, and satiny surface, has a most handsome appearance. A small proportion of the trees contain black, gummy veins which, although not injurious to the wood, as in some cases where the veins crack, yet appear unsightly. Others, again, develop white chalky marks in the pores like the San Domingo wood.

Many of the logs are beautifully figured or marked with wavy and curly grain, which is variously termed splash mottle, roe and mottle, fiddle-back, plum, snail, blister and cross-bar.

Good well-figured logs command very high prices for veneers, the record during the last twenty-five years being one which realised £13 : 10s.

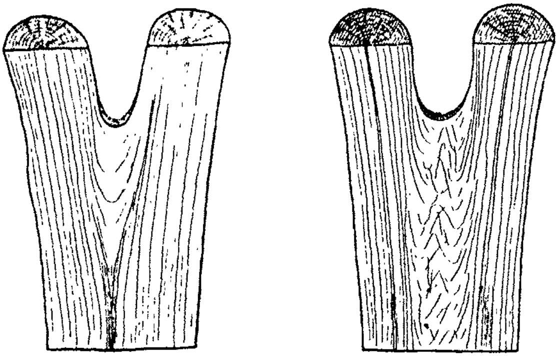


A Mahogany Tree, Cuba.

per foot cube. Probably the finest log imported during this period was one sold at Liverpool in 1901 by Messrs. Farnworth & Jardine for £750.

The wood from Cuba has largely taken the place of the old supplies from San Domingo. It is of the same character, though occasionally it surpasses it, for while the colour of the latter darkens with age, the Cuban wood retains its brightness and transparency. It shrinks very little in seasoning, does not warp or twist, and is very durable.

The colour of Cuban mahogany when first worked is very light, even lighter than some of the other sorts, but an impression prevails that it should be as dark as the old work which has matured with age. In order to comply with the somewhat unreasonable demand for this darker wood, it is customary to stain the new to the shade of the old. This is an unfortunate practice as it entirely spoils the transparency and beauty of the wood. Originally all the polishing was done by hand, without the use of polish ; this produces the best results. Staining and heavy french polishing ruin the colour, which otherwise would continue to improve with the lapse of time. Very beautifully marked wood is obtained by cutting through the fork of the main trunk, or of two large limbs, thus:



Single heart. Double heart, showing curl.

Sometimes the main trunk itself consists of twin trees which have grown together. This peculiarity occurs more often in Cuba mahogany than in any other. When this growth has taken place without the formation of any bark the wood presents a rich and agreeable appearance. These pieces when converted are known in the United Kingdom by the term " curls " and in America as " crotches." They are used extensively for panels and other decorative work.

The pores are irregular in position and size, and are more or less plugged with gum (?). The medullary rays are rough and irregular, showing rather obscurely in small flecks on the radial section, joined at right angles by rough similar light-coloured lines at irregular intervals.

Mahogany, Guatemalan. Weight, 38 lbs. 9 oz. Guatemala.

This mahogany is of a brighter red colour than Honduras, and in character and texture more resembles Cuban, and is, indeed, often indistinguishable from it. It finishes with an exceedingly smooth surface from the tool, and stands very well. It is obtainable in large to very large squares, ranging even up to 4 feet, but it is generally exported in rather short lengths, rarely over 14 feet long, the average being not more than 11 to 12 feet. The logs are somewhat faulty, often much shaken, and liable to wormy and decayed centres. Occasionally very sound fine trees are found, and a few are beautifully figured. The white chalky grain which is a feature of Cuban and San Domingo mahogany is very prevalent in Guatemalan, and it is largely used as a substitute for these varieties.

The concentric layers are sharp and defined to the naked eye; the medullary rays are distinct, regular, and nearly parallel; the pores are irregular in size and position.

Mahogany, Honduras. Weight, 29 lbs. 12 oz. Central America (Honduras).

Large quantities of mahogany have for many years been imported from Honduras; probably the best in quality of which has been shipped from Belize. It is received in hewn square logs and in the round, and also, of later years, in square sawn boards and planks. This, however, has been exported first from Honduras to North America, where it was sawn and thence re-exported in the various grades and qualities of the National Hardwood Lumber Association.

The wood is similar to the other mahoganies of Central America, though for a great many purposes it is superior to all. It is lighter in weight and milder in texture than the Spanish or Cuban. The dimensions in which it has been produced are larger than any other kind obtainable from Central America. In common with all other mahoganies, the forests yield a small proportion of highly figured pieces which are in great demand. Unlike the Spanish or Cuban wood, which darkens with exposure, that from Honduras bleaches, and when exposed to exceptionally strong rays from the sun, the colour inclines to a beautiful golden brown or even greyish shade. Although very occasionally a tree will be found to possess the white, chalky substance so common in the Spanish wood, yet it is unusual, and Honduras mahogany generally has a more or less black marking in the pores, some trees containing both the black marking and the white.

This timber has at times been called "baywood" (*q.v.*), the term referring to the Bay of Honduras, from which the wood was obtained.

The pores are irregular both in size and position, and are not very numerous. The pronounced medullary rays are parallel but irregular; they are crossed at intervals by similar lines. The rays show very strongly on the radial section as in sycamore.

MAHOGANY, PANAMA (probably *Cedrela*). Weight, 35 lbs. 9 oz. Central America.

Mr. Bradley says that there are two varieties of true mahogany in Panama, the light and the dark. The dark is, with some variations, similar to the mahogany of Central America, and bears a conical-shaped pod. The light variety is of the same family, but differs in leaf, seed, bark, grain, and colour, the seed being nearly round. The light mahogany grows on the wet land near the creeks in an accessible position. The timber of these two varieties may be classed together, as it has been found impossible to distinguish any material difference in the supplies of true mahogany which have come to the English markets. The quality and colour is very good, and resembles that of Honduras mahogany so nearly that it often passes for it. It has been imported in the round, and in hewn square logs of small and large sizes. The majority of these, however, have arrived in such a split condition that the wood has not been favourably received, and until some means can be found to bring the logs here in a more sound condition, little commercial development will ensue. Its uses have been the same as those for Honduras mahogany.

Besides these supplies, a large quantity of so-called mahogany has been exported to the United States and to this country. The correct term for this timber is "esparvie," and the name mahogany is improperly applied. There are also two sorts of esparvie—the light and the dark, the light being inferior, with small heart-wood and much sap-wood. It is subject to beetle attack, especially if cut in the wrong season. Generally speaking the tree is a native of the lowlands, but occasionally it is seen even on the tops of the hills. It is used but little locally. Its lasting qualities are greatly improved by creosoting. The dark variety is more often found in a dry situation, although it can occasionally be seen at the water's edge. It is much superior in quality, containing a greater proportion of heart-wood and much less sap-wood. It resists beetle attack better, and the heart-wood is in fact practically insect-proof. It is used along the coast as the chief timber for canoes and boats, an excellent recommendation in itself. About 1910 a cargo of what was probably esparvie was sent to Astoria near New York, where it was attacked by a beetle (possibly a weevil), which did an enormous amount of damage and spread to the other mahogany stored there. The resulting loss led to a law-suit in the American courts, and the judgment given by Judge Blackmore on that occasion is published in full here, as it deals with an important point regarding the liability of owners of timber in their relation as storage contractors. It is not known whether the cargo consisted of the light or dark varieties, but it is possible that it contained both. Notwithstanding this unfortunate incident, the dark variety is a valuable timber and is a good substitute for mahogany. Care should be taken to see that it is cut in the proper season and that measures are adopted to prevent the attack of beetles. The wood is straight-grained and is capable of a good finish from the tool. It is a yellowish-green colour, though occasionally this seems to vary, and some specimens are more of the red mahogany colour. It stands well and does not shrink unduly or warp or twist.

In the true Panama mahogany the concentric layers show sharply defined to the naked eye. The pores are open and irregular; the medullary rays are clear and regular, and are in all respects similar to Honduras mahogany.

With esparvie the fibres of the wood are of a soft, pithy nature and are not strong. The transverse grain does not cut clean from the tool. The pores are of variable size and often show in duplicate with a single shred of fibre between. The medullary rays are weak and obscure.

New York Law Journal, February 26, 1913

DECISION BY JUDGE BLACKMORE

Astoria Veneer Mills and Dock Co. v. Horsey & Son

The following propositions suffice for the disposition of this case:

1st. A contract for the storage of goods, wares, and merchandise which does not provide for any definite time of continuance may be terminated by either party on notice.

2nd. The contract in the present case provides no definite time of storage. The provision that if the logs are not withdrawn within a year the warehouseman may sell or store them elsewhere is not equivalent to an agreement on the part of the warehouseman to keep them in storage for the period of one year.

3rd. Even if the storage was for a definite period of time the development of the pest in the logs, which rendered their continued storage destructive of the property both of the warehouseman and the lumber of others in its care, justified it in terminating the contract of storage.

4th. Upon the refusal of the bailer to remove the logs, pursuant to notice and request, the warehouseman was justified in removing them and storing them in some other place for the account and at the risk of the owner.

5th. As it was the duty of the owner to remove the logs when notified by the warehouseman, he is liable for the charges and expenses incurred in effecting their removal, and also for such charges and expenses as had already accrued up to that time.

6th. Neither the plaintiff nor the defendant knew at the time when the logs were placed in storage that the insect pest was likely to develop, and neither of them was negligent so as to give a right of action to the other.

7th. The defendant neither created nor maintained a nuisance, and therefore is not liable upon that theory.

It follows that judgment should be rendered for the plaintiff to the effect that the storage contract was terminated and ceased to exist between the parties on August 16, 1912; that the plaintiff is released and discharged from all further responsibility to the defendant as warehouseman; that the defendant should be enjoined from further negotiations of the warehouse receipts, and that the defendant should pay to the plaintiff the charges incurred up to the time of the removal of the logs and its expenses incurred in the removal, and that the counterclaim of the defendant be dismissed.

MAHOGANY, SPANISH. *Swietenia Mahogani*, Linn. Weight, 48 lbs. San Domingo, etc.

The name "Spanish" mahogany has been applied to the wood which from the earliest date of the importation of mahogany came from Spanish possessions in the West Indies, and not, as some have erroneously imagined, from Spain. It is interesting to note that the origin of what has subsequently developed into an active trade was the bringing to England of a few planks and butts of mahogany as ballast by the captains of English vessels trading in the West Indies. According to report it was first heard of in 1597, but only began to arrive in England in marketable quantities towards the end of the seventeenth century. A cabinet-maker named Wollaston first introduced it in an important manner, and nearly, if not quite all the very beautiful and celebrated pieces of Chippendale made about 1750 were of this wood. Its unusually attractive qualities gave it the premier position, which it still retains, amongst decorative cabinet woods, and a considerable development in the trade ensued. The imports, however, were of a desultory character, and when the trees which were growing within easy access of the seaports were cleared, the trade in large pieces nearly ceased, as the country is very rugged and mountainous, and no means of transport except that of oxen and mules were available. Towards the end of the eighteenth century a very considerable demand arose for that form of mahogany known as curls or crotches. These pieces are obtained from that portion of the tree which contains a fork, either of the main trunk or secondary branches. (See Mahogany, Cuba.) To meet this demand great numbers of trees were cut down and all the forks carefully hewn out, placed on the backs of oxen, and carried down to the seaport. These pieces were in oblong hewn slabs, varying in size from about 9 inches by 5 inches to 36 inches by 24 inches, or as large as the animal could carry.

Meanwhile the main trunks, which were too heavy to be transported, were left lying on the ground, where many remained for half a century and more. During all this time an intermittent trade was being carried on, mostly, however, in smaller squares generally not exceeding about 16 inches by 9 or 10 inches in short lengths. The trade received a very considerable impetus as the result of the activity both in exploiting in Liverpool and elsewhere, and the writing abroad privately and publicly of Mr. Edward Chaloner, whose firm still occupies a leading position as mahogany brokers in Liverpool. A short pamphlet was published by him early in 1800, which must have been a great assistance to the trade at that time. At a later date a very enterprising engineer, M. Juan Bautista Nuñez, a native of the island, having studied engineering in America, was employed in carrying a railway system throughout the country. He very soon saw the advantages of collecting the large trunks of trees left on the ground, and accordingly carried on for many years a brisk trade in these squares, most of which were sent to Liverpool and sold at good prices. Many were of a beautiful colour and contained a very handsome figure, although often as much as 3 inches or even more of the outside wood was decayed through lying on the ground for so many years. San Domingo mahogany, or "City wood" as it was called, had, and still has, a peculiar attraction for many, and a few have been found so affected by their admiration for the wood that they may be said to have become mahogany misers. One cabinet-maker especially thought so much of some logs which he had purchased that he absolutely refused either to sell them or have them used for about fifty years. During all this time the logs with a saw-cut through were kept in his warehouse, where I was assured he used to go and dust them with a silk handkerchief. They were probably purchased by him in 1854, which dock rotation date, clearly painted, was easily read after his death in 1900, when I bought them. They were finely figured and of a beautiful colour and quality. Most of them were sent to America, some being used to decorate the house of Dr. Weld at Boston. The panelling around the Wigmore Hall in Wigmore Street is made of some of the richest old San Domingo mahogany that could be obtained, which was provided from some thick planks which had been lying in a cellar in Osnaburgh Street, London, for fully fifty years, and were so dirty and thick with dust that it was impossible to tell what wood it was until they were fully examined. The somewhat uncertain import of Spanish mahogany and the advent of a large trade from Cuba which supplied wood of magnificent texture and quality, which was in some respects superior to it, has resulted in Cuba wood being generally accepted as Spanish and used in its place. While the quality of individual Cuba trees has equalled if not surpassed that of San Domingo, yet in general the intrinsic quality of the latter excels all others. The trees have been found, however, to be more or less faulty in the heart, and generally do not yield such wide widths or long lengths as can be obtained from Cuba.

The wood is of a deep rich red colour, always darkening with exposure to light and air, although blazing sunlight does not give this result. It is almost, if not entirely, free from the dark gum streaks so prevalent in Cuba wood, and it nearly always shows a deposit of a white chalky substance in the pores. It has an exceedingly hard yet smooth surface, with a very bright transparent sheen, which gives a beautiful effect whether polished solely by hand, as it was originally, or by the method adopted later of french polishing. Although as in other cases the general shipments consist of plain wood, yet some trees provide the most beautiful figure which can be seen in any kind, and undoubtedly places the figured wood of Spanish mahogany in the highest category.

The pores are very irregular in size and position, while the white chalky substance with which they are plugged is peculiarly characteristic of the wood. The medullary rays are rather coarse; they are parallel and uneven, and are joined at irregular intervals by similar light-coloured lines.

MAHWA. *Bassia latifolia*, Roxb. Weight, 62 lbs. (Troup). India.

This timber is of a very bright, rich rose-red colour. The texture is hard and close, and much resembles that of pyinkado (*Xylia dolabriformis*), without, however, possessing any of the sticky feeling of this wood. Although there is a strong contrary grain it is capable of a smooth surface. Gamble says that it is used for house-building, furniture, and the naves of wheels. It would be useful for many purposes where a hard wearing, smooth wood is required. It would also be suitable for turnery, and it evidently stands well in all conditions. A few logs of this timber reached London several years ago. They were described as Indian jungle-wood; a ready sale was found for the wood at satisfactory prices.

The pores are neither large nor numerous. Gamble describes them as being "in short, radial wavy lines more or less in echelon." The medullary rays, which are exceedingly numerous, are very fine indeed.

MAIRE, BLACK. *Olea Cunninghamii*, Hook. Weight, 72 lbs. (Baterden). New Zealand.

Of this wood the New Zealand Board of Agriculture says: "Deep brown in colour, often streaked with black and highly ornamental, durable, even in grain, and takes a good polish. Procurable up to 20 feet in length and 12 inches in width. Used for framing for machinery, mill-wrights' work, and ornamental cabinet work of all descriptions." Baterden says that the timber makes good durable sleepers, piles, and fence posts, and it is said to make capital wood for large engraving blocks if properly seasoned, as it does not wear and bears high pressures. He adds that it takes a long time to season.

MANGEAO. *Litsaea calicaris*, Benth. and Hook. Weight, 38-48 lbs. New Zealand.

"White, firm, strong, and of great elasticity, and is suitable for a great variety of purposes requiring strength, toughness, and elasticity with light weight. Procurable in lengths up to 25 feet and up to 18 inches wide. Used for ships' blocks, coopers' ware, wheelwrights' bent stuff." (Board of Agriculture, New Zealand.)

MANUKA. *Leptospermum ericoides*, A. Rich. New Zealand.

This timber, the produce of the tea tree, is, according to the Board of Agriculture, New Zealand, red in colour, dense, straight-grained, and elastic. It is only procurable in short lengths which are small in size. It is used for wheelwrights' work and for inlaying.

MAPLE. *Acer saccharinum*, Wang.; *A. saccharum*, Marsh.; *A. macrophyllum*, etc. Weight, 37 lbs. 2 oz. Canada, United States.

This very important timber is drawn from a wide expanse of country and is obtained from many species. It has, therefore, an extensive range of quality, from the best hard, tough-grained white maple, through many stages to a soft, often bluish or reddish medium-textured wood. The best is always asked for and sometimes obtained; it is termed in specifications "hard, white, rock maple." A considerable quantity is found with a curly, twisted grain, and is known as "curly" or "bird's-eye" maple. This variety is much in demand for decorative work, and is generally used in the form of veneers. The whiter the wood in which this description is found, the more highly it is valued. It is used for trimmings of buildings, cabinet work, furniture, and general decorative purposes, especially in the saloons and state-rooms of yachts and steamers, and for railway coaches.

A particular variety of wavy, curly grain without bird's-eye marking has been called "Papapsco wood" (*q.v.*). Other uses for maple are very varied, and include rollers for several kinds of machines, agricultural implements, presses for heavy machinery, and for general furniture. A finely carved German coffer of maple, dating from the fourteenth century, can be seen at the Victoria and Albert Museum at South Kensington.

It has also been used for the backs of violins. The violin of the musician in Longfellow's "Wayside Inn" was

> Fashioned of maple and of pine,
> That in Tyrolean forests vast
> Had rocked and wrestled with the blast.

Perhaps one of the most important uses for maple is for floorings. For public buildings, schoolrooms, warehouses, and factories it is almost impossible to find its equal. The texture being of a tough, substantial nature, without any long or fibrous grain, the surface is not torn or flaked and withstands the hardest wear. Mr. John Collard says that the continual dragging of heavy pianofortes over the floor of the workshops (obviously a most trying test), makes little impression on a maple floor.

This timber is particularly susceptible to damp, and great care must be exercised in laying the floor to see that no swelling takes place.

The pores are exceedingly small and very regular. The medullary rays are strong and parallel, showing very distinctly, though finely, on the radial section.

MAPLE, JAPANESE. *Acer palmatum*, Thunb. and others. Japan.

It is impossible to say which, or of how many species the commercial supplies of Japanese maple consist, nor is it probable that at present it would be possible to ascertain. Goto names *A. palmatum* as being " abundant in Hokkaidō and the northern part of the main island." It is therefore probable that this species predominates in supplies. Fifteen different species are named by this authority. The character, general quality, and size of the shipments which have already arrived in England give the impression that it is all of one species. In appearance it is white, and the texture and grain of the wood are very good indeed, and compare to advantage with the best Canadian. For all purposes for which hard rock maple excels (see Maple) the Japanese is equally good, if not more satisfactory.

MARBLEWOOD, ANDAMAN. *Diospyros Kurzii*, Hiern. Weight, 66 lbs. (average of three specimens, Gamble). Andaman Islands, the Nicobars, Coco Islands.

This name is well chosen, as it would be difficult to find in nature anything more closely resembling marble. An alternative name is zebra-wood.

The wood is of a dense, ebony black, with stripes of golden-yellow and whitish-yellow, and it has a very close, hard, firm texture which is rather cold to the touch and is capable of a very smooth surface. All authorities seem to agree as to its liability to split and warp during seasoning. This is, however, a common difficulty with all timbers of this character, and, as in the case of boxwood particularly, the subject needs to be studied carefully in order to determine the most suitable time for the felling of the trees as well as the manner of their preservation afterwards. Probably screening from light and air for some time after felling, and very slow drying, would accomplish much in the desired direction. If regular supplies were forthcoming, this timber would be much sought after for ornamental cabinet work and inlay.

The rather numerous pores are very small. The medullary rays are exceedingly fine, close, parallel, and equidistant.

MATA-MATA. Weight, 68 lbs. 6 oz. Brazil.

This wood is of a dull nut-brown colour, and is capable of a smooth surface from the tool. It is, however, inclined to warp and twist to a more than ordinary degree, and also to split longitudinally with the growth, in numbers of straight, small lines. It could only be used, therefore, in small sections and for a limited number of purposes.

The pores are very regular and uniform, and are rendered apparent by a whitish halo. The medullary rays are very fine and clear, and show a stronger wavy mark at right angles, the whole making a beautiful pattern on the transverse section.

MATAI. *Podocarpus spicata*, R. Br. Weight, 40 lbs. New Zealand.

This wood, alternatively known as black pine, has not been imported on a commercial scale. The Board of Agriculture, New Zealand, reports it as being from light to deep brown in colour, very smooth and even in texture, strong and durable. It is used for general building purposes, especially flooring and weather-boarding, joinery and cabinet-making. Obtainable in long lengths and up to 24 inches in width.

Photograph by A. Rodger.

MELANORRHOEA USITATA, UPPER BURMA.

Melanorrhoea usitata, Wall. Weight, 60 lbs. Burma.

This wood, which can be obtained in large quantities, yields squares up to 30 feet × 16 inches × 16 inches. The wood is dark-red with yellowish streaks; it is heavy, dense, hard, and durable. It is used for building and bridges as well as for smaller work such as tool handles. It would be a handsome panelling wood.

Melia composita, Willd. Weight, 26–33 lbs. (Gamble). India, Ceylon.

This soft, reddish-white wood, which is identical with *M. dubia*, Hiern., shows a smooth glossy surface from the tool. Gamble says that "the structure resembles that of toon (*Cedrela Toona*), but all the pores are of the same size, and the wood is softer. . . . In Ceylon the outriggers of native boats are made of this wood, which is highly esteemed also for various other purposes."

The same authority includes this timber in his list of woods which are available in fairly large quantities and are likely to be worth trial.

In the spring zone there is a narrow band of large and open pores, the later growth showing small pores in a manner resembling English ash. The medullary rays are very fine.

Melia indica, Brandis. Weight, 50–52 lbs. (Gamble). India, Burma, Ceylon.

"A very important Indian tree. . . . The wood is durable; it is used for the construction of carts, in shipbuilding and for making agricultural implements, and in South India for furniture. . . . The use of it in furniture is believed to keep off moths and other insects.

"Annual rings doubtful; the wood shows alternating bands with numerous and with fewer pores; also pale concentric lines, but whether these are annual rings is doubtful. Pores scanty, moderate-sized, and large, often oval and subdivided; visible on a vertical section. Medullary rays fine, numerous, white, prominent, bent outwards where they touch the pores; the distance between the rays less than the transverse diameter of the pores." (Gamble.)

MERANTI. *Hopea* sp. Borneo, the Malay States.

This timber has occasionally been imported in sawn planks and sold under the name either of meranti or mahogany. It is of a light reddish colour and has been used for those purposes for which common mahogany is generally employed. Foxworthy states that the wood is identical with the lauan of the Philippines (*q.v.*)

MESSARANDUBA. *Leucuma procera*, Mart.; *Mimusops elata*, Fr. Allem. Weight, 71 lbs. 9 oz. Brazil.

It is not clear whether this wood is produced by either or both of the varieties above named. The same Brazilian name is commonly given to both, according to *Brazilian Woods*, which also mentions that in the State of Bahia it is named "apraiu."

The wood is bright brick-red in colour and has an exceedingly close, firm, hard texture, yielding a very smooth surface from the tool and possessing a bright metallic lustre. It is mentioned in the above-named

Photograph by G. R Keen

Melia composita Trees.

book as an excellent wood for piles and submerged work as well as for hydraulic work. It would be useful for chair and table legs, or any decorative furniture work where a very hard, smooth, durable wood is required, though it would perhaps be found too hard and heavy for ordinary cabinet work.

The pores are very scarce and are generally arranged in short wavy bands or groups; in some cases they are plugged. The medullary rays are exceedingly numerous, clearly defined and parallel, but irregular. At intervals they are crossed at right angles by similar light wavy bands, presenting a very pretty pattern.

Michelia Champaca, Linn. Weight, 28–42 lbs. (Gamble). India.

This wood, which, though hitherto unknown in European commerce, is likely to be imported in the near future, possesses, in common with most Indian timbers, a great variety of vernacular names. Many of these appear to be some variant of the generic name. The wood is of a canary colour and is very similar in all respects to *Michelia excelsa* (*q.v.*), particularly in its resemblance to American whitewood (*Liriodendron tulipifera*).

Michelia excelsa, Bl. Weight, 33 lbs. (Gamble). India.

This wood might well be named Indian " canary-wood," the resemblance to American whitewood (*Liriodendron tulipifera*) or canary-wood being so strong that it is very doubtful if one could be distinguished from the other. Gamble says it is " the most important building tree of the Upper Darjeeling forests, formerly used largely for planking, door and window frames, and furniture, but now scarce. The wood is very durable."

The pores are exceedingly small and obscure. The medullary rays cannot be seen on the transverse section with the lens (12 ×), but show in numerous fine, small flecks on the radial section.

Millettia pendula, Bth. Weight, 66 lbs. India, Burma.

This is a very beautiful wood possessing a rare figure, and it would be much sought for if a regular supply were established. It is of a dark chocolate colour, with black and reddish streaks, and somewhat resembles a rich dark partridge wood. It is capable of a smooth surface, but requires a sharp tool. It finishes with a bright metallic lustre. It would be valuable for cabinet work and inlay, and for walking sticks and turned articles of a decorative nature.

The pores are scarce, and generally plugged with gum. The medullary rays are very fine indeed, although clear cut; they are parallel and exceedingly numerous, and crossed by pretty, wavy lines of light ripples following the concentric layers.

Mimusops Elengi, Linn. Weight, 54-87 lbs. (Gamble). India, the Andaman Islands.

This timber, which is only obtainable in very small quantities, is exceedingly rare and has never yet been seen in commerce in the United Kingdom. Gamble speaks of it as being " very hard, close, and even-grained; sap-wood reddish brown, heart-wood dark red . . . used for house-building, carts, and cabinet work.

" Pores small, in short lines, which are generally radial but often irregular and oblique. Medullary rays very fine, very numerous, uniform and equidistant. Many parallel, wavy, concentric bands, narrow but conspicuous."

Mimusops littoralis, Kurz. Weight, 66 lbs. The Andaman Islands.

This is a handsome wood, sometimes known as bullet-wood, and greatly resembling *M. Elengi*, but it is of a lighter red and has a more wavy grain. It is smooth, and takes a good polish. Gamble says that it is apt to split. " The timber is extracted in squares up to 50 feet long with a siding of 2 feet. It is difficult to cut and saw or to drive nails into. . . .

" Pores very small, elongated, subdivided, in radial or oblique lines. Medullary rays very fine, very numerous, uniform, and equidistant."

MINGRIS. *Koompassia Beccariana*, Taub. Weight, 52 lbs. 14 oz. Borneo.

This timber is hard, and is of a dull, brick-red colour. In Borneo it is not considered durable, and it seems liable to twist and warp. It very much resembles the somewhat inferior varieties of *Dipterocarpus.*

The numerous open pores are filled with gum. The very fine medullary rays are parallel, but not quite equidistant.

MIRABOW or MIRABOO. *Intsia Bakeri*, Prain; *Afzelia palembanica*, Baker, and possibly *Intzia* (*Afzelia*) *trijuga*, Colebr. Weight, 60 lbs. 10 oz. Malay Peninsula, Borneo, India, the Philippines.

Intsia Bakeri occurs in the Malay Peninsula, Borneo, and Sumatra; no such narrow limits mark the coastal species, *I. trijuga*, which is widely distributed over the tropics of the old world from Madagascar and the Seychelles to India, Malaya, and over the Pacific Ocean as far as the Sandwich Isles. According to Foxworthy the woods of the two species are named respectively " miraboo " and " ipil " or " miraboo laut," but are so similar in appearance that he could detect no structural difference between them. It is possible that the wood of commerce may be derived from both species. It has been imported in sawn planks and boards of various sizes.

The timber is so hard and heavy that it is sometimes numbered among the "iron-woods." It is of a warmer or colder brown colour that darkens almost to blackness with age and exposure. The Borneo wood is one of the most valuable in that island and has been imported into England under the name of "Borneo teak" or "Borneo No. 1 teak," but it has none of the qualities of teak, and on account of its heaviness did not find favour as a substitute for that wood. The wood from New Guinea (probably *I. trijuga*) imported into Germany was also recommended as a substitute for teak. Mirabow takes a good polish and has been extensively used in the Far East in the manufacture of furniture; one fine piece possessed by Dr. Hose in Borneo formed the circular top of a dining table (8½ feet in diameter, and 2½ inches in thickness) and had been hewn from the trunk, moulded, and completely finished by natives solely with the aid of axes. Being very resistant to decay and to the attacks of insects (including "worms"), the timber has been successfully used in Borneo, etc., for constructional purposes such as bridges, houses, and posts.

In transverse section the wood shows many thin, sharp, light concentric lines dividing it into concentric zones which are of very uneven widths. The same section also reveals numerous light dots, evenly scattered; each dot has a light-coloured fringe and includes one or more pores, which are mostly visible to the naked eye. The coarse vessels (pores) contain substance that is sulphur-yellow or glistening red to reddish-black. The light-coloured medullary rays are fine and numerous.

MIRO. *Podocarpus ferruginea,* Don. Weight, 46 lbs. (Baterden). New Zealand.

The wood varies from light to dark brown in colour, is close in grain, moderately hard and heavy, planes up well, and takes a good polish. Some logs are nicely figured; it is, therefore, very suitable for cabinet-makers' work. It would also be useful for the turner, and for any ornamental work, and as it yields timber 10 to 18 inches square, and 20 to 30 feet in length, it would doubtless be fit for civil architecture.

MOERI. Weight, 51 lbs. East Africa.

This timber has not yet been imported commercially into the United Kingdom, but in common with other East African timbers it is now being exploited with energy, and the next few years will probably see a considerable development in export business. The colour is light brick-red, the wood taking only a comparatively smooth surface from the tool. It is of a hard nature and inclined to warp a little.

The pores are regular in both size and position, and are often seen in twin and triple formation. The medullary rays are parallel, often exceedingly close together, and comparatively strong.

MOLAVE. *Vitex geniculata*, Blanco; *V. littoralis*, Dcne. The Philippines.

This wood is yellowish or straw-coloured, hard, heavy, strong, and close in the grain, and possesses a figure or waviness that somewhat resembles satinwood; hence it may be found useful not only in building, but for cabinet purposes. Molave timber appears to be of good quality, and has the property of seasoning without much shrinkage or splitting; it also stands long exposure to the weather without showing any signs of deterioration. In the Philippines it is considered very durable.

Foxworthy says that for many purposes it seems to be fully the equal of teak. Amongst its many uses he mentions house- and shipbuilding, cabinet-making, doors, flooring, sleepers, and paving blocks.

MORA. *Dimorphandra Mora*, Bth. and Hook.; *D. excelsa*, Baill., or *Mora excelsa*, Baill. Weight, 76 lbs. 14 oz. (fresh cut). British and Dutch Guiana.

Notwithstanding the fact that as early as 1875 Laslett gave a good report of this wood it has never been seen in commerce to any extent, though of late years it has had some popularity for use as sleepers. Stone and Freeman give a very complete account in which they say that it is more durable than teak. They mention three varieties: the red, the white, and mora-bucquia; this last, however, is not considered to be durable. "Mora can be met with in logs 18 to 35 feet in length, 12 to 20 inches square"; these are the same sizes reported by Laslett.

Fourteen logs of this wood were received in London during the war, having been diverted from Havre. They were imported from Surinam, and were straight and clean and of good quality. The wood is a yellowish-brown colour, and contains an oily and glutinous substance in its pores, which is probably conducive to its durability. It is of close texture, and has occasionally a twist or waviness in the fibre which imparts to the logs possessing it a beautifully figured appearance, and incidentally adding considerably to their value.

The pores are conspicuous and numerous, and are generally in duplicate or triplicate, more or less filled with gum. The medullary rays are strongly defined, irregular, frequent, scarcely parallel, and show clearly on the radial section.

MORRELL. *Eucalyptus longicornis*, F. v. M. Weight, 64 lbs. Western Australia.

"It is a strong, dense, hard wood, and has an interlocked grain. It is of a dark brown colour and is used for wheelwrights' work, tool handles, etc. It is also used for mining timber. . . . Transverse strength, 16,900 lbs. per square inch. Tensile strength, 18,000 lbs. per square inch" (Lane-Poole).

Morus laevigata, Wall. Weight, 45 lbs. India, Burma.

This handsome wood is yellowish in colour, is hard and close-grained, and polishes well. It darkens on exposure. It is suitable for carving and turnery, and deserves to be better known and more widely used for decorative cabinet work. A large quantity is available in squares measuring 40 feet × 14 inches × 14 inches.

MULBERRY. *Morus alba* and *M. nigra*, Linn. Europe.

Of this timber, Elwes and Henry say: "The wood of the [black] mulberry is very like that of Robinia in texture, colour, and useful properties; but yellow when fresh, it acquires in the course of time a brownish-red tint. It takes a good polish, and is often used for making furniture."

Holtzapffel says that "Bergerou very strongly recommends the white mulberry, which he describes as similar to elm, but very close in the grain and suitable for furniture." This wood should be highly valued for cabinet work or inlay, as it is quite equal to, and in some respects surpasses, those timbers which are imported from abroad often at considerable cost, and which are not in any way superior.

MYALL. *Acacia pendula*, A. Cunn. Weight, 76 lbs. Queensland, New South Wales, Victoria.

It is possible that some confusion has arisen from time to time between the produce of *Acacia pendula* and *A. acuminata*. There is a considerable resemblance between the two species.

Stone describes the wood as "very dark brown with light-coloured lines, few, if any, black bands." He adds that as an ornamental wood it is much prized by cabinet-makers and turners. Baterden says that myall and other acacias have been recently selected by the Ordnance Department of Great Britain for the manufacture of spokes for gun-carriage wheels.

NIRI. *Xylocarpus borneensis*, Becc. Weight, 40 lbs. 4 oz. Borneo, the Philippines.

This is a hard timber, close and fine-grained, and of a dull coffee-coloured or reddish-tinted brown with darker brown gum streaks. It is rather liable to warp, but will take a fine smooth surface from the tool. Foxworthy mentions that a similar product from East Africa and the Fiji Islands, which is used for fine furniture, sandals, piling, etc., is obtained from *X. oboratus*, A. Juss, and *X. granatum*.

The annual rings are slightly apparent. The pores are numerous, evenly distributed, and generally filled with gum or resin. The medullary rays are fine, close, and parallel.

Nutwood. *Dicorynia Maraensis*, Bth. Weight, 49 lbs. 3 oz. (fresh undried sample). Dutch Guiana.

Fifteen logs of a timber to which this name was given were received in London during 1914. According to information received, this wood is called " locus " in British Guiana. The logs are hewn square, and in shape and size bear a strong likeness to greenheart logs. The wood is of a light nut-brown colour, and is capable of a smooth surface from the tool, with rather a shiny or lustrous gloss. The tangential grain is interspersed with short darker brown lines formed by the pores. The grain and texture might be compared to a mild African mahogany, which in these respects it much resembles. It gives all indications of being likely to stand well without warping or shrinking.

The pores are scattered and irregular in size and position, some being rather large and open. The medullary rays are fine, close, and parallel, but irregular. They are rather obscure, and are joined at uneven intervals by similar white lines. The concentric layers are quite distinctly marked.

Oak. *Quercus* spp.

There are many different species of oaks, all belonging to the genus *Quercus*, and confined to the northern hemisphere : thus the " she-oaks " of Australia, " African oak," and others from the southern hemisphere are not oaks, nor even allied to them.

In Great Britain grow two native species and their hybrids, and both of these are deciduous, that is to say, they annually shed all their foliage in autumn. These extend widely over Europe, through France, Germany, Austria, and Russia, and supply the British, Austrian, and Russian oak. Going southwards to the Mediterranean region the deciduous species are more numerous, and are reinforced by evergreen oaks (holm oak, cork oak) which are never leafless. Passing on to India the number of kinds, both deciduous and evergreen, is still greater, but none yields timber that is exported to any extent. Again, in Japan quite a number of kinds of oaks grow, and among them are two deciduous species that supply to England and Europe generally, the well-known Japanese oak. Crossing the Pacific to Canada other species of deciduous oaks are encountered, and again on going south to the United States they are increased in numbers and supplemented by evergreen species ; from this wealth of species are derived the medley of timbers known as American oak and (from evergreen species) " live oak."

The commercial oaks may be ranged under three main headings.

1. **European** : (*a*) British ; (*b*) Russian ; (*c*) Austrian ; all, or nearly all, derived from two closely-allied species.

2. **American** : (*a*) deciduous, derived from a mixture of species ; (*b*) " live oak," derived from one or more evergreen species.

3. JAPANESE: derived from two closely-allied species.

For decorative purposes commercial oak is supplied in the form of boards and so forth of two kinds: *wainscot* or quartered oak, and *plain* or bastard sawn oak. As plain oak is sometimes supplied in fulfilling contracts demanding wainscot oak, it is necessary to have a clear knowledge of the meaning of the latter description. This can be acquired by a consideration of the history of its manufacture and the origin of the term "wainscot."

Oak and other straight-grained European timbers cleave most readily along the grain in the direction of the medullary rays, and this is particularly true when these are broad and deep. In such a case the splitting takes place along the deep rays which are thus exposed, and produces the "silver grain" familiar in oak. When oak is thus split into thin boards these are wedge-shaped (being thinner towards the middle), and such are termed "clap-boards," and are still so known in the United States. Their shape particularly adapted them for use as shingles for roofs. The word "clap-board" itself denotes the mode of preparation, as it means a board produced by cleavage (cf. German word *klaffen*, to split asunder). For panelling, such boards were worked on the face side, so that ancient oak panelling shows the clash or silver grain broadly spread over the surface to an extent unobtainable by means of the saw, except in isolated cases. Wainscot boards thus prepared by cleavage were imported into England at a very early date.

According to Professor Joseph Wright, the word "wainscot" is of Dutch origin. The early Dutch form of the word is *waeghe-schot*, in which *weaghe* (Old English, waeg; German, Wege) means a wave, and *schot*, a partition, a closure of boards. Thus, according to Professor Wright, the "wave" refers to the wavy pattern on the wood (the silver grain caused by the medullary rays). "Schot" may refer to the mode of preparation, by which the wood was cleft or partitioned into boards, or to the purposes fulfilled by these in the construction of partitions in a house. Professor Wright states that in the seventeenth century, or possibly earlier, *waeghe-schot* became *wagenschot*, as the first element of the word was popularly associated with *wagen* (a waggon, a wain). This verdict is of significance from two points of view:

(1) It shows that the word wainscot was applied to a wood showing silver grain, the oak, and that this was necessarily divided along the medullary rays.

(2) It denotes that the application of the word wainscot to any kind of wood not cut on the quarter, is illegitimate.

Professor Skeat, however, says that the word is a corruption of the Old Dutch *waeghe-schot*, wall-hoarding, from the Old Dutch *waeg*, a wall, and *schot*, a partition.

It has also been said that it is derived from the Dutch *wagen* (waggon) or *wen* and *schot* (partition), which might refer to the sides of a waggon or to a division within it. In former days, waggons when journeying long distances had divisions for sleeping accommodation. This kind of partition was introduced into the house, the rooms of which were *wagenschoted*—wainscoted. Much of the panelling of early date was carried out in so-called deal, the produce of *Pinus sylvestris*, but wealthier people were able to gratify their taste by using oak. As at that time saws were not used, the only possible method of conversion was that of splitting, and as oak splits on the medullary ray, the whole of the wood used showed a maximum display of clash or figure.

It will thus be seen that whichever of the theories of the origin of the term be accepted as the most probable, there is no question that for a room to be trimmed in wainscot oak the wood used must show figure or clash on the face, and that the term " wainscot " used in connection with oak means figured oak.

While the meaning of the term wainscot as applied to oak wood is beyond doubt, the architectural meaning of the term has wandered from the original so far that it denotes a wooden boarding, sometimes panelling, of the walls of a room. The consequence is that there might be ambiguity in a specification demanding that a room shall be wainscoted with oak panelling, but there should be no misunderstanding when the demand is that a room shall be panelled with wainscot oak. Yet to avoid all possibility of litigation it would be well to use the term " quartered " when wainscot oak is wanted, and possibly even supplement this term by " (well, boldly, best) figured."

Boards obtained by cleavage are necessarily wedge-shaped. With the advent of the saw it was possible rapidly to cut flat boards, but obviously if such boards were sawn exactly along the medullary rays the waste ot material would be very great. It was therefore necessary to adopt some practicable and economic approximation to the results obtained by cleavage.

The following are among such methods of sawing:

The trunk is sawn down the middle (Fig. 1); the marginal pieces of the two halves are sawn off and there result two billets, termed wainscot billets. If these are cut in the manner shown in Fig. 2, that is, at right angles to the broad flat face and parallel to the two flat sides, the cut *a-b* is parallel to the medullary rays and the board yielded will be the most highly figured. A cut along *c-d* or *e-f* will traverse the medullary rays most obliquely and therefore show some figure, but the silver grain will be smaller and less marked. In fact, the nearer the board is to *a-b* the larger and bolder will be the figure; the nearer to *c-d* or *e-f* the smaller and less bold will it be.

Yet when wainscot billets are cut sufficiently narrow (Fig. 3) all the boards show sufficient figure to be termed wainscot oak. If the billets, however, are cut wider (Fig. 4), it is evident that the boards cut from the outside will be plain oak, or approximate to it, so that a board *g-h* will actually be plain oak. Hence if the wainscot billets be too wide not every board cut is wainscot oak.

This mode of producing wainscot billets has been adopted during late years with oak from Riga, Libau, and, to a limited extent, from Japan. The butts are sawn or hewn as shown in Fig. 5.

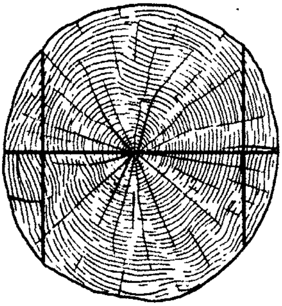


FIG. 1.

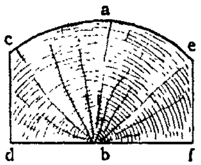


FIG. 2.

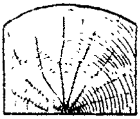


FIG 3.

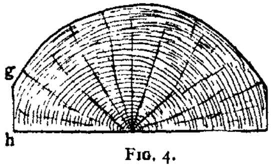


FIG. 4.

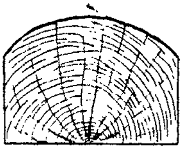


FIG. 5.

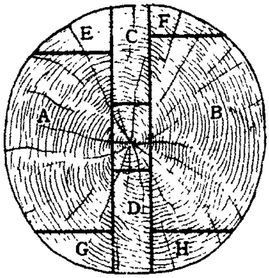


FIG. 6.

Another method of sawing which is possible if the trunks are of considerable diameter, is pursued in the case of Austrian (Hungarian) oak (Fig. 6). Each butt yields two wainscot billets, *A* and *B*, and two wainscot planks, *C* and *D*, 3 to 8 inches in thickness. The centre and the remaining marginal pieces *E*, *F*, *G*, *H*, are not used to produce wainscot oak. The two billets are cut in the manner already described.

These considerations of the mode of cutting, lead to the conclusion that not every board cut from a wainscot log or wainscot billet is necessarily wainscot oak, for the marginal boards will be plain oak if the billet or log be too wide in relation to the original thickness of the butt.

So far the matter has been discussed solely from the point of view of history and decorative effect, but there is another important aspect of the question. Shrinking and warping during drying are very much less along the medullary rays than in a direction at right angles to these. The result is that true wainscot panels will shrink, warp, or crack less than plain oak panels under the same conditions. Hence, even did oak possess no silver grain, true wainscot panels (cut in the quarter) would be more valuable than plain panels.

From all points of view then it must be rigidly insisted that wainscot is that cut on the quarter and showing very considerable silver grain in the form of transverse bands. It will be seen, therefore, that the original panelling in oak, or, as it was termed, " wainscoting," consisted necessarily (since the whole of the wood was reft or split) of highly figured timber showing the " clash " or " flower " to the greatest extent, but that at a later date, with the advent of the use of the saw, a change gradually took place. According to an account by " W. S." published by the *Timber Trades Journal*, August 7, 1915 : " The wainscot oak in the old houses in the country was mostly English oak ; there was not much Dutch or Riga wainscot before the reign of William the Third (1689–1702). I think Sir Christopher Wren introduced a great deal of it into this country ; he was building for a Dutch king, therefore it was natural that he should use it." John Armstrong (1835) says : " Most of the timber was cut by windmills at Westzaam and Zaandam and others near Rotterdam, and shipped either from Ostend or the Holland ports." He also reports that George the Fourth (1820–1830) sent his representative over to Holland to purchase wainscot oak for Gothic fittings in Windsor Castle, but although he obtained the wood he does not seem to have been very pleased with the quality, partly because he could not select billets for figure, but had to accept them as they came. George the Fourth has not been the only disappointed man. Complaints and disputes leading to law-suits and arbitraments have been continually recurring. It would therefore be desirable that, to prevent further disappointments and disputes, there should be a general agreement that where work is specified to be executed in wainscot oak, it should be generally understood that the wood should show a preponderance of good figure or clash, and especially so in the panels. At the same time, having regard to the altered conditions since the age when " split " wood was used, reasonable regard should be paid to the economical conversion of the material. For instance, the appearance of the finished work would not suffer if a reasonably wide latitude were allowed in the use of plain wood in mouldings, styles, and rails. A brief consideration of the foregoing remarks on conversion will conclusively show the loss or waste of attempting to produce all the timber dead on the quarter, as it appears when split.

OAK, AFRICAN. *Lophira alata*, Banks. Weight, 70 lbs. Tropical Africa.

The produce of this timber is not often seen in our markets, although J. M. Hillier in the *Kew Bulletin* No. 2, 1913, mentions that some was brought to Liverpool from the Gold Coast, where it is known as Karkoo. He adds that " it is the favourite wood for railway sleepers and heavy constructional work generally . . . [and] owing to its great weight and the difficulties of shipment it has not yet received the notice which its merits deserve." In a list of forest trees of the West Coast of Africa, prepared by Sir Walter Egerton, it is stated that this timber is known in Yoruba as " Tonhon " and in Benin as " Uqbeberi." Laslett speaks of African oak, but from his description it is not clear that the wood to which he refers is the same ; in fact, he names the wood as the produce of *Swietenia senegalensis* or *S. Khaya* from Sierra Leone, and as I have seen at least five different hard-woods from the coast, all of which have been termed " African oak," and which, although all possessing similar qualities of heaviness and hardness, differed materially in all other respects, it seems impossible to be sure of the identity of the different varieties.

OAK, AMERICAN. *Quercus alba*, Linn., and other *Quercus* spp. Weight, 41 lbs. 14 oz. North America.

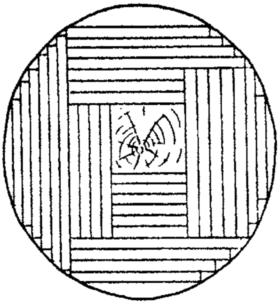
The very important part which this wood plays in the timber supply of this country is shown by the immense quantity imported every year. The value in money has approximated to a million pounds yearly, ranging from £675,000 during 1909, to over a million in 1913. Its use far exceeds that of any other oak, and constitutes more than five-eighths of the whole supply from abroad. This remarkable result is not due to its superiority over other supplies so much as to the enterprise and energy of the American merchant in providing it in a suitable manner and at a moderate price, while its transport is facilitated by advantageous railway and steamer freights. The timber so provided is the produce of a great many species mixed indiscriminately. The sources of supply have been continually extended as the available forests disappeared under the woodman's axe, and the once famous Indiana white oak is now no longer obtainable, at least for export. The result, so far as that part of the shipments which is used for constructional work is concerned, is not of consequence, as the present supplies are suitable, but for cabinet and decorative work the mixture of the variety of grain and colour is disadvantageous. The colour varies from a pale yellow brown through various shades to a light brick-red. The wood of *Q. alba* "is of a pale reddish-brown, straight-grained, moderately hard and compact, tough, strong, and of fair durability. Being remarkable for its elasticity, planks cut from it may, when steamed, be bent into almost any form of curve, no matter how difficult, without danger of breaking or splintering. This characteristic renders it especially valuable for shipbuilding purposes. The wood opens very sound; and as it shrinks but little, and almost without splitting, during the process of seasoning, there is nothing to prevent its extensive use in railway carriage-building, civil architecture, and generally in the domestic arts. . . . In the experiments that were made, it was found white oak compared very favourably with all the foreign oaks, but proved to be slightly inferior in strength to the English oak" (see tables of experiments, p. 350 *et seq.*). So wrote Laslett in 1875, and it would be impossible to give a better description.

Of late years the logs have occupied a very important place, as they yield strong timber of long length up to over 60 feet, and large squares, up to 2 feet 6 inches, perhaps more, of clean, straight grain and good quality. This, however, is neither of the same character nor of so high a standard as the old shipments. It is used mostly in railway carriage and waggon building. The timber is not very durable and should not be used in England in those places where it is required to remain sound for a great number of years, although much can be done to increase its durability by a wise system of ventilation around those parts which are built into walls. Unfortunate results with American oak beams were experienced in its use for the roof and other places in the museum at Barnard Castle. The especial qualities of toughness and elasticity, together with a plentiful supply of long lengths of straight grain which can be easily obtained free from knots, give the planks and waggon scantlings a very justifiable popularity. An enormous quantity has been used for sills for windows, this being principally due to the low price at which it has been provided, as for such purpose it is doubtful if it is sufficiently durable. Planks and boards for decorative work are obtainable in what is termed "plain" or "quarter sawn." The plain boards are sawn so that the surface shows the tangential section, while the quarter sawn displays the radial (see diagram, p. 170).

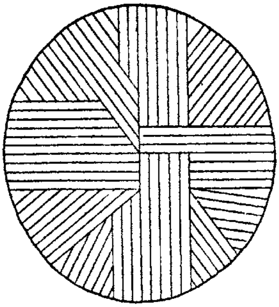
A boxed heart square is generally taken from the heart.

It will be seen that quarter sawing entails greater cost and more waste, which consequently makes it more expensive. Immense quantities of these descriptions have been used in every kind of cabinet, building, and decorative work. The product of the log is handled as it comes from the saw and is selected into grades according to an inspection regulation decided by the National Hardwood Lumber Association.

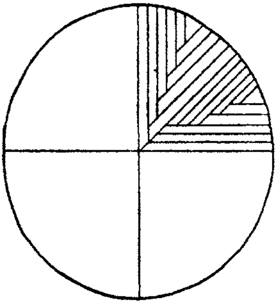
This authority regulates the different qualities by rule, the product being divided into what are called "firsts and seconds," "No. 1 common," "No. 2 common," and "culls." A very large quantity of floorings is imported ready prepared. All flooring strips in America are of a much narrower width than that which has been commonly adopted in the United Kingdom; the usual widths of imported American floorings are nominal 3 and 3½ inches. The wood is always plain sawn, quarter sawn floorings being unknown. It is tongued and grooved, and generally bored for secret nailing: the ends also are tongued and grooved, so that they can be joined without cross-cutting to fit the joists. The lengths are much shorter than those commonly used in English prepared floorings, ranging as the wood falls from the saw, from 18 inches to 16 feet, the average being about 8 feet. A very excellent plan of hollowing the under side is adopted in order to provide for a free current of air, and the consequent ventilation of the floor to prevent the attack of dry rot.



A. Plain sawn.



B. Quarter sawn.



C. Quarter sawn.

According to the *Pioneer Western Lumberman*, San Francisco, November 1, 1915, the largest oak tree in the world is to be found in San Benito. "This lordly tree measures thirty-seven feet six inches in circumference. The natives, who declare that it produces a ton of acorns every year, take great pride in it." The note remarks that this tree surpasses that which previously was supposed to be the largest and which was known as the famous Hooker oak of Chico, California, named in 1872, which rises to a height of 105 feet, but is only 21 feet 8 inches in circumference.

The pores in the spring-wood are large and regular. The medullary rays, which are larger and bolder than in any other oak, are very numerous and continue, more so than in other varieties, in a direct line from the heart to the circumference. The converted wood displays, therefore, when quarter sawn, a larger and bolder figure or clash than it is possible to produce from any other variety of oak.

OAK, AUSTRIAN. *Quercus pedunculata*, Ehrh., and *Q. sessiliflora*, Sm. Croatia, Slavonia.

Austrian oak is mainly yielded by the forests of Slavonia and Croatia, and therefore would be more correctly termed Hungarian oak; it is conveyed by rail to Fiume and shipped thence.

Trees of large dimensions, straight and clean in growth, and possessing lofty branchless boles, are obtained from these forests. A number of the latter, whether owned by the State, by public bodies, or by private persons, are administered by the State, which ensures proper management, including regulation of the felling and due regeneration of the stock. The result of this enlightened system, which is followed by a number of Continental countries, but not, unhappily, by this, is that there will be a considerable maintenance of the supply of Hungarian oak. Trees of large size will decrease in number in the future, and are not expected to be available twenty years hence. The cause of the depletion of these large trees is twofold. On the one hand, such trees are of great age, and therefore cannot be replaced by others in a few years. On the other hand, modern German methods of forestry determine that the trees shall be felled at the moment when they represent the maximum profit (as measured by interest on capital, and condition of the remaining forest); and this moment is reached in all European timber trees long before they have obtained impressive dimensions. Yet at present very large oak trees are still found in Slavonian forests, which also include a wealth of fine old ash, elm, lime, and hornbeam trees, and are so old as to have some claims to be regarded as truly primeval.

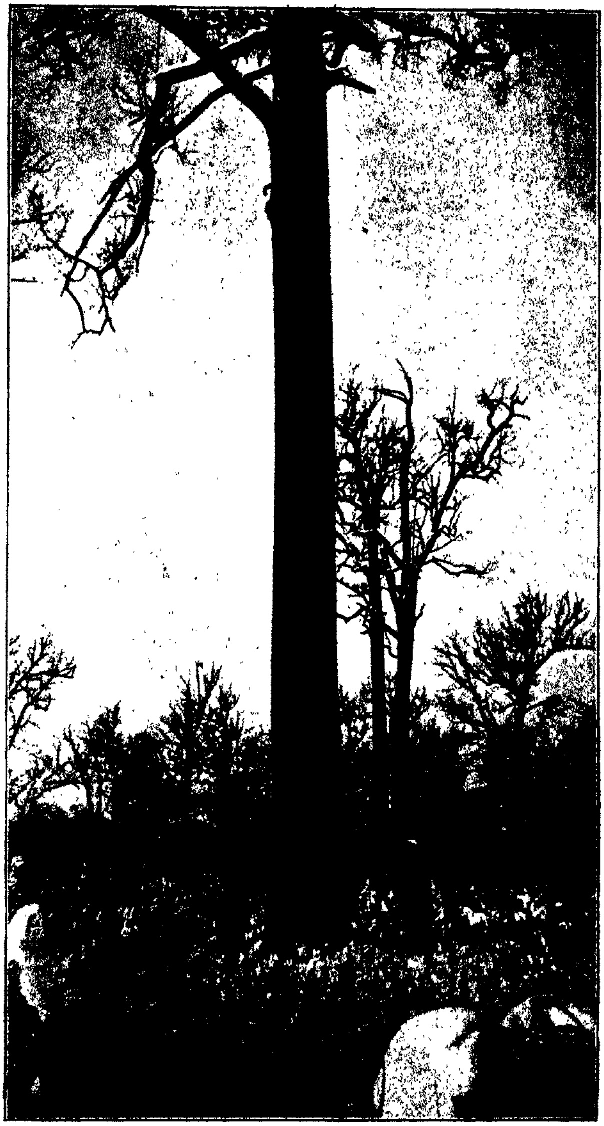
Trees of such outstanding quality as regards height, girth, and cleanness of stem are not, however, confined to such areas as these Slavonian

Photograph by kind permission of H. J. Elwes, Esq.

Oak in Kyre Park, Worcestershire.

forests. Yet with that curious attitude in which the average Englishman ignores the value of the products of his own country and utilises instead those of foreign lands, such trees as these become well known, whilst others in England, of equal quality and as large dimensions, remain unnoticed.

For instance, in Kyre Park, Worcestershire, the property of Mrs. Baldwin Childe, is an oak grove containing over one hundred trees, whose clean, straight stems are of a wonderful height. H. J. Elwes, writing of them, says "... they are not so remarkable for their girth as for the way in which they run up with clear stems to a great height. The two tallest are certainly over 130 feet by my own measurements in 1907.... The largest ... has a stem 83 feet long by 17 feet 8 inches in girth at 5 feet, and contains 1031 cubic feet of timber. Fourteen of them contain



B.—Oak Tree of the Socna Forest, Slavonia.

over 600 feet, and the smallest tree in the grove has 97 feet, which is considered a big oak in many districts. . . . There is an oak of remarkable size in another part of the Kyre estate. . . . It is 113 feet in total height, with a trunk nearly straight to about 90 feet high, where the head begins, and 15 feet 10 inches in girth" (see page 172).

Thus it will be seen that as against a diameter of 4 feet 2 inches and 4 feet 6 inches in the case of the two exceptional trees in Slavonia, among sixteen trees at Kyre Park, the four largest have perhaps a larger diameter, while the height of the lowest branch exceeds that of the Slavonian.

The value of the British-grown tree exceeds that of the Continental, yet in the spring of 1914 princely oaks were sold within fifty miles of London at less than 1s. 9d. per foot cube, whereas I was told that in Slavonia an equivalent of 7s. 6d. per foot cube had been paid for similar trees for the English market.

The accompanying illustrations[1] (pp. 173, 176) represent two oak trees which grew in the Socna forest in Slavonia. The following were the dimensions of the two main trunks:

	Tree A.	Tree B.
Complete height	130 feet (*circa*)	130 feet (*circa*)
Height to lowest branch . . .	42 feet 3 inches	35 feet 9 inches
Diameter at height of 5 feet . .	4 feet 2 inches	4 feet 6 inches
Diameter at height of 22 feet 9 inches .	3 feet 6 inches	
Diameter at height of 35 feet 9 inches .		Over 4 feet

The wood of such venerable oak trees is often "over-ripe" or otherwise faulty; it is, in other words, more or less infected by wood-destroying fungi, which are freely seen in similar reputedly virgin forests of Bohemia. If the timber be only slightly affected it can be used in the manufacture of furniture, but is not sufficiently good in quality for export. Large sound trunks from Slavonia are dispatched mainly to Holland and Germany.

The method of cutting Austrian oak into billets and wainscot wood has already been described (see page 166). In this respect also the English merchant shows a short-sighted policy with regard to the conversion of the native timber. With the foreign oak the best methods to suit the particular requirements of this country have been found and acted upon, but there have been no such wise methods employed with the home-grown product. The cost of conversion in this manner is naturally greater than in the ordinary way, yet what is allowed to one timber is denied to the other. Even where some one has had sufficient enterprise to adopt this process with British oak he has received neither support nor encouragement. The considerable demand in England for Austrian oak, which depends to a large extent on the automatic repetition of specifications, arose for the following reasons. Many years ago it was found possible to secure large butts of Austrain oak capable of yielding billets particularly clean and free from defects, and of a width exceeding that procurable elsewhere. Moreover, the wood is mild in quality, and shows bold silver-grain. In colour it is of a uniform yellow-brown, and in this respect, as well as in its grain, is often indistinguishable from Russian oak. Apart from these features it is probably slightly inferior to the timber obtainable from the more northern forests of South Russia.

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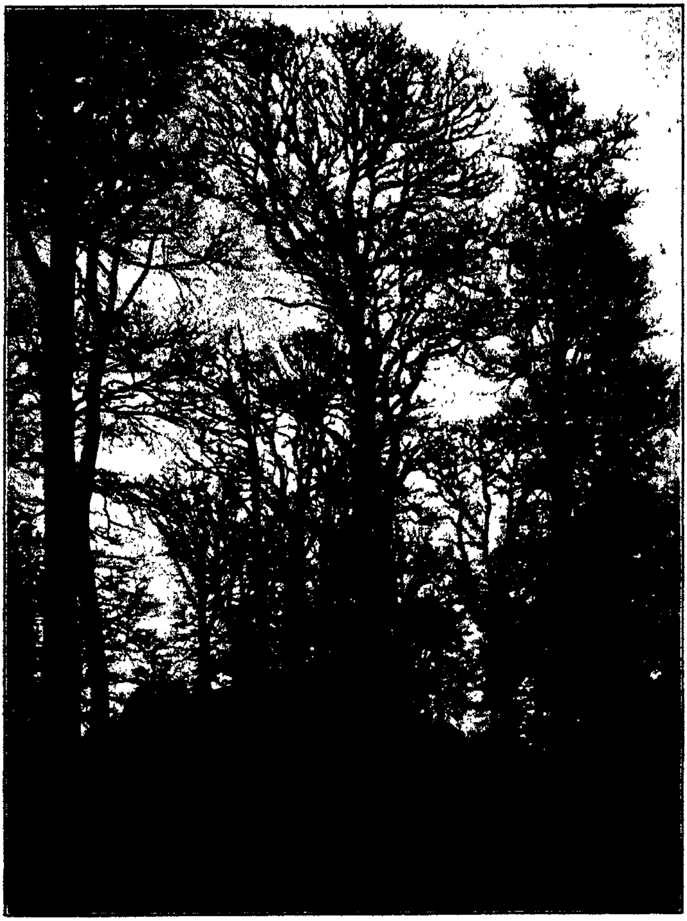
[1] For these photographs and the accompanying information I am indebted to the Photographic Studio "Etienne."



Photograph by kind permission of H. J. Elwes, Esq.

Oak Grove, Kyre Park, Worcestershire.

A.—Oak Tree of the Socna Forest, Slavonia.

In addition to the supplies of Austrian oak cut in the manner already indicated, a certain amount is exported in the form of round bark-covered butts, or these sawn into planks or boards, also in the form of square-edged planks (both plain and figured) and boards. The last-named serve for flooring and parquetry, but the trade in these for such purposes is limited by their high cost, as it is possible to procure equally suitable oak from other sources at a lower cost. In Hungary, however, an extensive industry in oak parquetry is conducted.

In the autumn of 1914, after the war had broken out, H.M. Office of Works issued a specification demanding the use of "Austrian oak" for the panelling of "armament buildings," then intended to provide the office for the Board of Agriculture. Following a letter of remonstrance addressed to the *Times* by "Man in the Street" H.M. Office of Works altered the specification to a demand for British oak, and this was therefore used for trimming two rooms, which, beautiful in design and execution, have a very handsome effect. The work was carried out by Messrs. Cleaver, and a brass plate has been affixed which notes the botanical variety of the wood and the places whence the oak trees came.

OAK, BRITISH. *Quercus pedunculata*, Ehrh., and *Q. sessiliflora*, Sm. Weight, 52 lbs. 14 oz. The British Isles.

The two kinds of British oak timbers hardly differ, if they differ at all, in their general qualities. On the whole, it is possible that the product of *Q. pedunculata* is slightly stronger and harder than that of *Q. sessiliflora*, although, as the proportion of supplies of the latter is so much less than that of the former, I have been unable after close observation over many years to detect any real difference, and it appears to me that the quality of both varieties either as regards mildness or strength, is dependent upon the soil and the situation in which they have been grown. There is no doubt that there is a much more marked difference in the qualities supplied from Continental sources. Laslett says: "It is the prevailing opinion that the wood of the *Quercus Robur pedunculata* is the best in quality, and that the *Quercus Robur sessiliflora* is slightly inferior to it"; but while agreeing generally in this opinion, I feel bound to admit that during a long experience in working them, I have not been able to *discover any important difference* between them. We find indeed the wood of the two species so closely resembling each other that few surveyors are able to speak positively as to the identity of either. It is only by tracing the log from the felling of the tree to the hands of the convertor that we are able to say that the timber of the *sessiliflora* is a little less dense and compact in texture than that of the *pedunculata*."

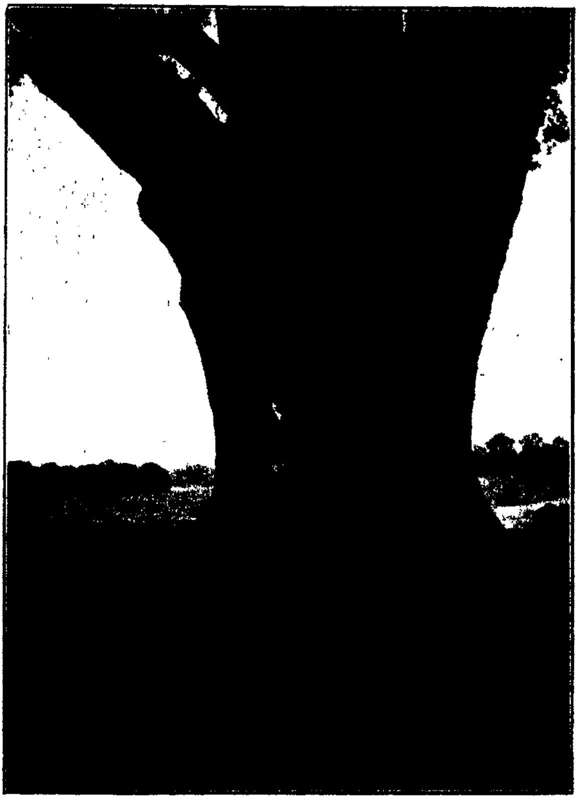
With the knowledge of Laslett's experience in mind I have never allowed a single specimen of *sessiliflora*, many of which have come under my notice, to pass by unexamined. I believe it would be impossible to prove that there is any difference.

There is no oak in the world comparable to British oak. Pre-eminent among British timbers it stands unchallenged for its strength and durability, which have become proverbial, and emblematic indeed of the nation which owes the foundations of its greatness to the "wooden walls" of oak which in past centuries compassed the waters of the globe, and gave this land the title of "Mistress of the Seas."

The unsurpassed strength of British oak is universally admitted, although to provide statistics of comparison is impossible, since the experiments made have not been sufficiently numerous, nor have those which have been made taken into account various factors, such as the amount of moisture in the wood. Evidence of its great durability has been provided in the report on European oak (*q.v.*), but interesting additional examples are cited by Laslett in connection with his discussion on the relative merits of winter-felled and spring-felled oak. Among these cases are those of certain ships built for the Royal Navy, the wood used being winter-felled oak. The *Sovereign of the Seas*, built 1635, was pulled to pieces forty-seven years later and rebuilt, "and the greater part of the materials were found to be in sufficiently good condition for re-employment." The *Royal William*, built in 1715-19, was finally taken to pieces after a service of ninety-four years. The *Montague*, launched in 1779, was in active service and good condition in 1815. Opposed to these examples is that of the *Hawke* sloop, of whose oak timber one-half was winter-felled and the other half spring-felled. "She was built in 1793, and ten years later was in such a general condition of decay that she was taken to pieces, no difference being then observable in the condition of her several timbers." This does not imply that winter-felled and spring-felled timber are equally liable to decay. In this case the winter-felled timber "was barked standing in the spring of 1787, and not felled until the autumn of 1790." In considering the meaning of these facts relating to the *Hawke* it is important to remember that wood-destroying fungi often require a starting-point opposing slight resistance to them, but after that stage is passed, having acquired full vigour, they can attack timber that would have successfully resisted their opening onslaught. In any case, the general consensus of opinion among Government authorities in England, France, and other countries, is that winter-felled oak is the more durable.

Ordinary British oak timber is procurable in two extreme and various transitional forms. The general characters of the two extremes were well described by Laslett as follows: "The English oak tree, if grown in sheltered situations or in forests, frequently reaches a height of 70 to

100 feet with a clear, straight stem of from 30 to 40 feet [I think it would be more correct to put this figure at 30 to 60 feet.—A. L. H.] and a circumference of 8 to 10 feet, and much larger specimens (though now only rarely to be met with) were formerly common. If grown in open and exposed situations, it is generally shorter, and frequently takes strange and eccentric forms, assuming a somewhat curved and crooked shape; this, however, is one of its most valuable characteristics, as naturally curved timber is almost indispensable for wood shipbuilding. It is when grown under these conditions that it appears to attain its maximum of hardness, and is often found so gnarled and knotty that it is difficult to work." Grown in appropriately shaded forest the tree casts off its



THE "TWELVE APOSTLES" OAK ON LORD PETRE'S ESTATE AT BRENTWOOD, 14 feet high to the big branch; girth, 27 feet 1½ inches; diameter, 11 feet.

lower branches as the trunk elongates, so that knots are lacking on the long bole; and the trunk produces straight-grained wood arranged in annual rings of more or less even width. In these respects it resembles the typical forest-grown Russian, Austrian, and Japanese oak. When, however, grown out in the open, or in well-lighted woodlands, the trunk retains its old branches, which develop into low pitched boughs and produce huge knots. Moreover, the energy of the tree is diverted to producing a thick stumpy trunk with wide fibrous annual rings and broad medullary rays. The annual rings are, however, apt to be very unequal in thickness, so that the grain is uneven and far removed from the straight by the intervention of numerous larger and smaller knots. The result is that this wild-grained timber is not so strong as the preceding kind, but has a much more varied, decorative effect, which is enhanced by bold silver grain, unsurpassed by any other European commercial oak.

It is strange to note that although British oak is generally admired and highly valued when it bears the stamp of antiquity, yet at the present time foreign varieties are more often used in preference to it. When, however, it is so employed, there is the assurance that not only is it beautiful and ornamental, but it is capable of enduring sound and excellent for future ages, and thus preserve a record of the art and craft of the period in which the work was executed. The foreign oak which is more commonly used results in work which differs little in its spiritless uniformity from any ordinary stained and varnished wood.

An illustration of the enduring qualities of British oak can be found in the hammer-beam roof of Westminster Hall, which, erected in 1399, lasted for over 500 years and has only recently been repaired. In contrast to these may be mentioned the elaborate fifteenth-century carved work in the Frari Church and the Church of S. Stefano in Venice (alluded to elsewhere), which, executed in Italian walnut, is now perforated with worm holes and is crumbling to dust. Other examples of the superior effect resulting from the use of British oak can be seen in the Court of Criminal Appeal at the Royal Courts of Justice, London; the subcommittee room at Lloyd's Registry in Fenchurch Street, E.C.; in the benches and ends of the seats in Lanteglos Church, near Fowey, in Cornwall, and the following places:

The Thistle Chapel in St. Giles' Cathedral, Edinburgh, designed by Sir Robert Lorimer and built by Mr. N. Grieve. The British oak used in this building was sawn and sticked for over fifty years and was grown in Essex.

Liverpool Cathedral, designed by Mr. Gilbert Scott, the oak for which work came from the same source as the above.

The dining-room of a house at Hyde Park, executed by Messrs. Holland & Hannen, which is a reduced copy of the Brewers' Hall.

The offices of the P. and O. Company in Leadenhall Street; many of the steamers of the company are also trimmed with British oak.

Mr. G. T. Wills' house at Sunningdale, built by Messrs. J. Bentley & Sons, Waltham Abbey. The timber used in this instance was mostly grown on Lord Chesham's estate at Latimer.

Mr. T. E. Collcutt's house at Totteridge, Hertfordshire; Mr. Alfred B. Smith's house, The Crossways, Totteridge; and Highwood, Highwood Hill, all possess beautiful woodwork entirely executed in British oak.

Much of the charm of this work depends not only on the varied colouring of the wood, but upon its very irregularities and faultiness, yet architects often reject such wood on account of its knots and uneven grain. Fortunately of late years its use for decorative purposes has increased, and as its beauty has become more appreciated, the difficulties attendant upon an irregular and uncertain demand tend to diminish. The present inadequate supplies will doubtless be augmented as the craftsman learns that he can execute his work as easily and economically as with the foreign oak.

It is customary to consider British oak as difficult to work and incapable of standing well after completion—an erroneous and wholly groundless opinion. Much of the modern work mentioned above was executed by O. Ayton and his sons, who, originally country carpenters, were artists in this work, all of which is in perfect condition without shrinkages or any other fault.

For constructive work the strength and durability of oak are well recognised. It would be difficult to estimate its life when used submerged. The beech piles which formed the foundation, laid in 1202, of Winchester Cathedral were held together by oak spikes, which, a rich black, were found perfectly hard and sound when they were taken out after 700 years. James Thomson & Co. of Peterborough found perfectly sound English oak in the foundations of Holy Trinity Church at Hull, built *circa* 1270, and said that in their long experience they had never found any other buried woodwork in as sound a condition. Large-sized logs and beams up to 35 feet in length, and 20 inches square were used for the lock-gates for the London Docks. These were taken up for repair and renewal in 1915, having then been in position for periods ranging from 60 to 200 years; they were found to be hard, in splendid preservation, and nearly black. The oak which replaced the damaged portions was obtained from the Duke of Wellington's park at Strathfieldsaye and measured 35 feet in length, squaring 18½ by 19½ inches. A tablet giving particulars of the wood and date of submersion was affixed to these logs before putting them down. Elwes refers thus to a prehistoric boat which was dug up at Brigg in Lincolnshire in 1884.[1]

"*This wonderfully preserved dug-out was hollowed out of one huge oak log 48½ feet long, and approximately 6 feet in diameter, which showed no signs of branches, a log which must have contained nearly 1000 feet of timber, and which could not be matched now in England, or, so far as we know, in Europe or North America. . . . The boat was found embedded in the blue and brown clay which underlies the peat, and is considered on geological evidence . . . to be from 2600 to 3000 years old.*"

Oak is not unique, however, in its durability when totally submerged or completely buried in soil, for other timbers share this quality with it, but it does excel other woods in remaining sound for long periods when exposed to air and weather. The beams and uprights of the half-timbered Savoy Farm at Denham, Buckinghamshire, 500 to 600 years old, were in 1915, still in a wonderful state of preservation.

Yet oak timber is by no means immune from decay, especially if used without thought or care. For window sills it would be difficult to find a better timber, and it is therefore generally specified, yet the wood is continually being used in an entirely unseasoned state, and even before fixing is generally painted. The wet and the sap within the wood are consequently sealed up, and decay probably begins immediately the sill is fixed. Under such conditions the commonest description of Scots pine would last for a longer time.

A short time ago the oak beams in the roof of Bowes Museum, Barnard Castle, were found to be in a very bad state of decay, and had to be taken out and replaced with new. It is not certain whether these were all British or all American oak, but Professor Annan of Armstrong College, Newcastle, in his report attributes the dry rot of the beams to the fact that they were placed in position while unseasoned, then thickly varnished, and the ends built into the walls so that no evaporation was possible, all ventilation having been stopped.[2]

When used for pit-props and railway sleepers the life of oak is probably never more than, if as long as twenty-four years, for when unventilated or exposed to alternate wet and dry, it readily succumbs to the attacks of dry rot (*Merulius lacrymans*).

In contracts, engineers and architects sometimes demand that the oak timber shall be from trees which have been felled for from two to seven years (generally not less than five years) prior to use. This matter is generally discussed elsewhere (see p. 317), but it may here be reiterated that any such condition is actually harmful.

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[1] Described in a lecture by the Rev. D. Cary Elwes, and published in 1903—*A Prehistoric Boat.* Stanton & Son, Northampton.

[2] Private note. O. S. Scott, Curator, Bowes Museum, 19/2/14.

Being easily cleft, oak is excellently adapted for the manufacture of palings, staves, barrels, wheel-spokes and the like, and is largely so employed. It would also be well adapted for shingles for roofs, though its use for this purpose is not now required. When steamed it is readily compressed, and in this form supplies keys and trenails for fixing railway lines. The presence of a considerable amount of tannin in oak should exclude its use in contact with iron. When so used discoloration ensues, and ultimately results in the disintegration of the wood and the corrosion of the nails, fastening, and other iron work. Copper is therefore preferably used, otherwise the iron work should be galvanised.

English oak is sometimes attacked by a fungus (*Chlorosplenium aeruginosum*) which stains the wood a brilliant vivid green. When so affected it is used for inlay work in Tunbridge ware. In Great Britain and Europe generally the tree is peculiarly liable to lightning strokes, which seriously damage, and often destroy, the whole value of the wood. The timber is attacked by various wood-destroying fungi, and is liable to many defects.

The seasoning and conversion of oak is of the utmost importance; too little attention has been paid to this in the past. Excepting where large timber is required for beams, dock-gates, and the like, the best results are obtained by cutting the timber into planks and boards of the sizes likely to be required, at the earliest possible moment after the tree has been felled. The trees should never be sawn through and through, but on the quarter. For all joiners' work, and especially where ventilation is restricted, the seasoning should be complete before use. Even after thorough seasoning, where the best work is desired, the wood should first be roughly worked, then kept for a short time in a warm chamber as near as possible of the temperature of the room in which it will finally be placed, and not until after this should it be fixed together and finished. It is desirable that a period of about forty-eight hours should elapse before fixing the wood, after breaking the skin by fresh planing, as on each occasion when this has to be done a further change and shrinkage will occur, even if the wood is 200 or more years old.

OAK, BROWN. *Quercus Robur*, Linn. Weight, 47 lbs. 13 oz. The British Isles.

When certain individual British oak trees (*Quercus Robur*) are felled, their ordinary heart-wood is found to be partially or wholly changed into a richer toned reddish-brown wood which is known as "brown oak." It was formerly, and indeed it is occasionally even now, among English timber merchants and others in this country, called "red oak." The colour is much like that of polished crocodile leather, very variable in character, depth, and richness. It may be uniformly of a comparatively light brown, or again a deep, rich brown, having in some cases lighter streaks; while in some portions from one to two inches wide, the ordinary colour does not appear to have been affected at all; again, the warm brown may be spotted and streaked with almost black veins, presenting a rich appearance. This last form is called " tortoise-shell " pattern.

It is a strange fact that one single tree may be affected without others near or around it showing the slightest trace. Thus, out of a group of trees in Farming Woods Park, one large tree was found to be of a fine rich colour, although some five or six other similar ones quite close to it were of the ordinary colour. On the other hand, it sometimes happens that in a group of trees all are found to be more or less affected. This was specially noticeable in a small wood on the golf course at Stanmore in Middlesex, where a large proportion of the trees which were cut down proved to be all brown, while some were slightly affected and others not at all. One or two very old and large specimens of undoubted American red oak (*Quercus rubra*, Linn.) growing in England were found to have this peculiarity.

In the trunk the brown wood occurs either at the base, extending upwards to a variable height, or extending downwards from the crown towards the base to a variable depth, and it appears probable that in a few cases it may start from a large knot below the crown and extend somewhat downwards, but in such cases the proportion of the tree affected is slight. The trunk may be wholly of a rich brown from the base to the crown; it may taper brown to a point, or prove to be brown on one side only. An example of this was noticed in a tree grown at Radlett, Hertfordshire, where the brown wood at the base of the trunk extended apparently completely across the heart-wood, then tapered very sharply in an upward direction, becoming at the same time confined to one side of the trunk, and continued thus upwards, gradually tapering to extinction at an approximate height of 15 feet. In connection with partially unilateral distribution may be mentioned the case of an oak tree which grew near a stream. The bole, when only 18 inches in height, gave way to two erect stems, each of which was about 18 inches in thickness over a length of 12 to 15 feet. The stumpy bole showed " brown oak " on one side only, and the erect leader topping that side was also characterised by brown wood, whereas the leader springing from the other side of the bole possessed quite normal wood. The brown wood extending up the trunk is often arrested by an extensive knot, and in any case a large knot acts as an obstacle. In the case of trees which have been pollarded, the trunk may be found to be all brown up to the crown, but it is rarely, if ever, found that all the leaders are also brown, although in some cases the greater number are. A very large tree obtained from Danbury Palace, near Chelmsford, Essex, had five secondary trunks growing out of the butt, all of which were of a very rich brown colour. (After the tree was sold, a man was idly pulling out the decayed wood from a hollow in the side of the trunk when he felt something hard, which he discovered was a small coin, afterwards found to be of Roman origin.) Much more often, however, in the case of pollarded trees, only one or possibly two of the secondary trunks carry brown colour through, and in most of these cases it is noticeable that the secondary trunk or trunks which are affected occur on that side of the main trunk which has displayed the stronger and richer colour.

In considering the origin of this wood it must be emphasised that "brown oak" is the product of the ordinary species of British oaks (presumably *Q. pedunculata* and *Q. sessiliflora*). The cause of the phenomenon was unknown until recently, when it was investigated by Professor Percy Groom.[1] The following are the results obtained. The heart-wood is laid down as perfectly normal heart-wood, which is subsequently converted by the action of a particular kind of fungus into brown oak. The scientific name of the fungus is not absolutely established, though in all of three specimens, coming from different parts of Great Britain, it was one and the same in species. The fungus causes the wood to assume first a yellow colour, then a richer brown, culminating in a deep reddish-brown or sometimes blackish-brown. It advances most rapidly along the grain of the wood, often at first being distributed along certain strands of the wood and causing these to assume a colour darker than that of the remainder. This usually temporary condition explains the origin of the tortoise-shell variety. The fungus advances more slowly along the medullary rays. These two methods of progression explain how the wood may become thoroughly infected by the fungus, which, however, grows very slowly and incompletely in a tangential direction. Artificial infections of boards or ordinary heart-wood of the oak led to the artificial production of brown oak. The fungus is of a somewhat exceptional type among wood-inhabiting fungi, for it shows only the feeblest power of attacking the actual wood substance; while it is converting ordinary heart-wood into brown oak, it feeds on other substances in the wood (probably tannin among others). This fact is of importance in appraising the connection between the fungus and the decay exhibited in certain brown oak trees.

It is widely known that "brown oak" trees when standing sometimes undergo decay. I have observed many cases in which the trunks of oak trees showed the butt in a complete condition of white-rot up to the height of from 3 to 6 feet, but above this the heart-wood was firm, hard brown oak. This was specially noticeable with some fine butts which were cut down on Lord Chesham's estate at Latimer, Buckinghamshire. One of these trees, measuring about 36 inches in diameter, appeared when felled to be valueless on account of the white fluffy, decayed wood which completely covered the trunk within a distance of an inch or two of the bark. Upon cross-cutting from 3 to 4 feet through the tree was perfectly sound, and of a very dark brown colour.

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[1] Percy Groom, "'Brown Oak' and its Origin," *Annals of Botany*, 1919, vol. xxix. pp. 393-408.

Moreover, " brown oak " trees sometimes show signs of ill-health as evinced in stag-headedness. Do these facts indicate that the browning process is one of incipient decay caused by the fungus responsible for that browning? Stag-headedness is a symptom of various kinds of diseases of the oak tree, some associated with wood-destroying fungi and others not so, and it is very apt to occur on ordinary oak trees occupying light soils which are apparently unfavourable to the development of " brown oak." Again, Professor Groom thinks that the fact that large brown oak trees occur without showing any traces of decay in their hard, firm " brown oak," accords with the feeble powers of attacking wood substance shown by the browning fungus. On the other hand, there are many kinds of wood-attacking fungi that cause decay in the sap-wood and heart-wood of the oak tree. A number of them gain admittance through wounds, and several can simultaneously attack heart-wood at the same point. One or more of these may be responsible for the rotting of " brown oak," and at present there is not the slightest reason for believing that the fungus causing the production of " brown oak " is responsible for such rotting, or that " brown oak " is wood in a condition of incipient decay. The matter requires further investigation. As only the heart-wood of the tree is affected, and the sap flows up to the leaves exclusively in the sap-wood, it is not surprising that trees containing " brown oak " show no external signs of its possession. The fact that " brown oak " owes its origin to a fungus, and therefore arises only when the tree is infected, gives some explanation of the distribution of " brown oak " trees and of " brown oak " in the individual tree.

Such trees are found in Great Britain in regions extending from the south up to Scotland. A large number of old oaks in the northern vicinity of London are infected. This has been particularly noticed at Stanmore, Wembley, Edgware, Mill Hill, Totteridge, Enfield, Finchley, Golders Green; also at Radlett and Stoke Park. Many handsome trees which developed the tortoise-shell pattern, and also the uniform brown colour, were found in Stoke Park, Stoke Poges, and were all shipped to America, some having since been utilised to form the panelling and furniture in the City Hall, Chicago. It is significant that in Cassiobury Park, close to several of the above-named places, where the soil is light, no " brown oak " has been found. Light soil in general seems to be inimical to its development. The peculiarity occurs in trees varying from very old ones to those which are perhaps as young as twenty years. As no evidence exists as to the date of infection, it is quite impossible to draw any conclusions as to the rate of production of " brown oak."

A remarkable fact about this beautiful form of English oak is that although it is found at our doors few people in England are even aware of its existence ; yet it is known in America as one of the finest decorative woods ; indeed, in general, Americans appear to think that it is the only form of oak which grows in England. There it is called simply " English oak," the term " brown oak " being seldom used. H. J. Elwes, *Trees of Great Britain and Ireland*, quoting Mr. C. M'Kimm, a distinguished American architect, says : " We regard it as the most beautiful oak in the world . . . preferred to all others for its finer quality, richer colour, and endurance." The hall and staircase at The Lynch House, Totteridge, Hertfordshire, is entirely panelled and furnished in " brown oak," from trees which grew on the Totteridge Park estate, and which provide a fine example of this wood. The trees were cut down some twenty years ago, and their roots can still be traced. Elwes says : " The best example that I have seen of fine brown oak work in England is at Rockhurst, the residence of the late Sir Richard Tarrant, in Sussex. This was done by Messrs. Marsh, Cribb & Co. of Leeds, with brown pollard oak, showing very varied figure " ; and since the date when he wrote this the same firm has completed some equally fine panelling in the dining-room of Mr. H. J. Elwes' house at Colesborne. Indeed, it is doubtful if this is not on the whole a still finer example.

In my experience no such timber has ever been found either in France or elsewhere on the Continent. Professor Groom, however, says that he has examined the French *chêne rouge*, derived from the same species of tree (*Quercus Robur*) and has found the wood so similar that with the naked eye he cannot distinguish it from " brown oak," but the microscope revealed considerable differences between the British and French woods, thus indicating that the causes of the anomaly in the two cases are different.

The question of seasoning is of more than ordinary importance in connection with the use of English oak, and especially with the brown variety under discussion. Excepting in the case of burry logs, they should always be cut as nearly as possible on the quarter. After cutting, the planks and boards should be stowed in a position entirely sheltered from sun, wind, or rain, and preferably in a place where drying will proceed slowly. This last precaution is specially necessary with curly, twisted, or burry grain. When first cut, the wood is unusually strong, and is liable to split and warp, although when seasoned it stands very well. A plan adopted by some has been to place the saw-dust of the wood thickly in between the planks, but this practice may result in fermentation and formation of fungi, and it is very doubtful if it is effective.

Elwes, writing of some magnificent specimens of panelling and wainscoting executed in brown oak for Dr. Weld, of Boston, U.S.A., by Messrs. Noyes & Whitcomb, thus describes the method of seasoning employed by this firm. "Dry white fine boards fresh from the hot-air kiln are laid on each side of the oak boards, and properly stripped [sticked] in an open covered shed. When the moisture has been partially absorbed, they are all turned over and again sandwiched between fresh dry fine boards; thus saving a great deal of time, which is rarely given to season timber properly in America, and preparing the wood to stand the conditions of dryness, which are more trying to furniture in American than in English houses."

Veneers cut from "brown oak" (especially from burr-wood) require very special care in drying in order to avoid splitting, and to keep them flat. They should be stored in a cool place, a basement for preference, packed as tightly as possible, covered with tarpaulin, and loaded above with weights. After a time they should be carefully turned over, wiped with a cloth, and re-packed with the reverse side uppermost.

OAK, BURR, and POLLARD. *Quercus pedunculata*, Ehrh., and *Q. sessiliflora*, Sm. Great Britain.

Burr-wood shows the grain of the wood running in all directions, so that the cut surface is marked by small twists, curls, or bird's-eye specks, and often has scraps of enclosed bark ("gaul"). As is always the case with burr-wood, that of the oak is particularly liable to warp, twist, and even crack during drying, and especially so when used in thick pieces; it is therefore invariably cut into veneers. When well chosen, burr-wood of "brown oak" produces a variegated decorative effect which is unrivalled of its kind; while the burr of ordinary oak yields veneered panels whose ornamental qualities will be regarded by many as superior to those of certain more costly woods, including bird's-eye maple. Burr-wood is produced by pollard as well as other oak trees.

A pollard tree is one whose poll (head) has been cut off when the tree has reached a considerable age; pollard willows, cultivated to produce osiers for basket work, provide a familiar example. The results of such decapitation are: first, that the growth in length of the main trunk is permanently arrested; and secondly, that a number of branches shoot forth from the top of the headless bole and develop into more or less vigorous boughs.

Pollard oaks are abundant in England, and include most of the old oak trees in Epping Forest, as well as many in Sherwood Forest. All the old oaks in Moor Park, Rickmansworth, were and are of this type, and according to tradition owe their state to very human motives. It is stated that in 1685 the Duchess of Monmouth, desirous of revenging the beheading of her husband, caused all the oaks in this park to be pollarded and thus rendered for ever incapable of supplying timber for the Navy of the hated English.

The more or less numerous branches ultimately springing from the head of the pollard tree gradually produce at the summit of the trunk a thick mass of burr-wood. Moreover, the rest of the trunk thickens, and from it there may burst forth countless young shoots, clusters of which produce at their bases large swollen humps, known as burrs. Elwes describes a good example of the result of this mode of growth: the trunk that he investigated was " ten feet high and nine feet in girth. . . . Its wood, when cut into veneer, was throughout the whole thickness of the

A Basal Burr.

tree more like that of bird's-eye maple than oak, and has served to mak the front of a very handsome bookcase."

Yet burrs are by no means confined to pollard trees, for they frequentl arise on ordinary oak trees at various heights up the trunk. The causes responsible for the production of burrs are often unknown. In the oak, they appear to arise sometimes as a consequence of attack by rabbits, which gnaw the bark at the base of young trees and thus stimulate the trunk to abnormal growth. This is localised and gives rise to a burr, which may extend completely round the base of the trunk. A basal burr of this extreme type is shown in the foregoing illustration, which depicts a transported rootless trunk standing on a flat bed of concrete. The tree originally grew in Stoke Park.

It is thus evident that the terms "burr" and "pollard" should not be employed as synonyms. Still less correct is it to confine the term "pollard oak" to burr-wood of the "brown oak tree," as was formerly the custom among timber merchants. This burr-wood of "brown oak" was much admired and used from fifty to a hundred years ago, when it was known as "pollard oak."[1] It was more appreciated in the north of England, though some fine examples of Victorian cabinet work, made by Gillow and others, are to be found in the south (a handsome round table of that period veneered with this wood stands in the Savile Club, London).

OAK, CORK. *Quercus Suber*, Linn. Spain, Portugal.

This oak supplies the cork which is used for commercial purposes. It is the produce of the extraordinarily developed corky layer of the bark. Pliny mentions the use of cork for stopping bottles and casks, and also for nets and lifebelts. The general employment of corks for glass bottles, however, appears to date only from the fifteenth century.

OAK, FORMOSAN. *Quercus pseudo-myrsineaefolia*, Hay. Weight, 75 lbs. Formosa.

This wood resembles that of *Q. Morii*, Hay, in weight, texture, and general characteristics. It is, however, of a brighter colour, almost of a rose shade, while, lacking the darker streaks of this wood, the effect is more uniform. It is a very beautiful wood, and should be highly valued for cabinet and decorative work.

The transverse grain has a very pretty appearance. The pores are scarce and small. The principal medullary rays are very strong, and running parallel between them are numerous equidistant secondary rays, with similar fine white lines at right angles; the beautiful effect thus given resembles delicate lace, or a fine spider's web.

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[1] So far as can be ascertained, at that time "maiden" "brown oak" (*i.e.* wood having the ordinary straight grain) was never sought for, and was used merely when accidentally secured.

OAK, FORMOSAN. *Quercus* sp. Weight, 66–72 lbs. Formosa.

Two specimens of Formosan oak have been submitted to me, about which nothing further is known but that they are a species of *Quercus*. It is therefore impossible to describe them by separate names, although the timber differs widely. They closely resemble the product of the live oak, being hard and heavy, and having a close grain, while they are also capable of a very smooth surface—more so indeed than is any other oak. The colour of one is the beautiful greyish brown, which only after many years is assumed by old English oak panelling. With the broad strong clash or figure of the pronounced medullary rays and its pleasing colour, this wood should be in great demand, and would make beautiful panelling and furniture.

The pores are very small and not numerous. The principal medullary rays are strong and broad, with numerous fine secondary rays between, parallel and regular. There is a pretty wavy or ripple-like appearance of a small white marking at right angles to the medullary rays.

Another variety is of a bright uniform biscuit yellow colour. This wood possesses very unusual markings caused by the pores and the rays. In the combined result much of the wood is almost like the marking of a leopard, and would give a very pretty effect in decorative work of all kinds.

The pores are scarce and very small. The principal medullary rays are broad and strong, with innumerable very fine secondary rays running parallel between them. These are joined at right angles by fine markings, and give the appearance of delicate lace.

OAK, HIMALAYAN. *Quercus spicata*, Smith. Weight, 58 lbs. India.

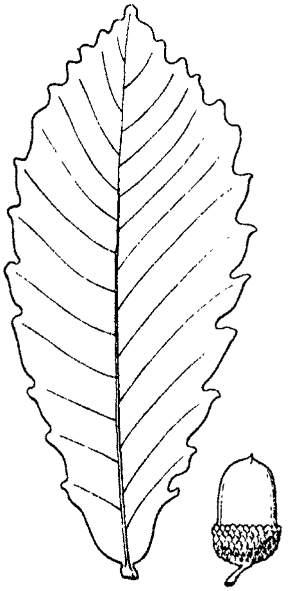
The wood is of a rather dirty reddish-brown colour, showing little of the general characteristics of *Quercus*, while it has a rather rough and fibrous grain. Troup recommends it as being durable and not inclined to warp. He mentions it as being used for "building (Assam) well construction, ploughs, mortars, helms of boats."

There are singular, short dark wavy ripples, following the lines of the concentric layers. The pores are very small and scarce. The medullary rays are strong, wide, and conspicuous.

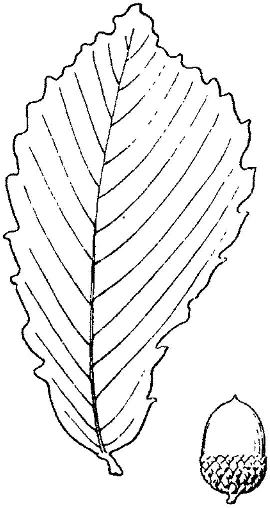
OAK, HOLLY. *Quercus Morii*, Hay. Weight, 67 lbs. Formosa.

The wood is of a bright salmon-red colour, streaked with wide dark reddish-brown markings, and is of a very hard texture which is capable of a smooth surface. The colour and the pretty marking of the pores which make a pleasing pattern on the radial section, and the strong wide clash or flower caused by the medullary rays, render the wood very valuable for ornamental, cabinet, or decorative work. It has never been imported into this country, but would undoubtedly be much sought for if available when known. It is one of the most beautiful of all the oaks. According to the report of Mitsui & Company there is an estimated supply of about 30 million cubic feet.

The pores are very small and scarce. Besides the strong, broadly marked principal medullary rays there are, evenly distributed between them, smaller secondary rays which are numerous, very fine, and parallel.



QUERCUS CRISPULA, "OHNARA."



Q. GLANDULIFERA, "KONARA."

OAK, JAPANESE. *Quercus grosseserrata*, Bl.; *Q. crispula*, Bl.; *Q. glandulifera*, Bl.; and *Q. dentata*, Thunb. Weight, 40 lbs. 12 oz.–47 lbs. 13 oz. Japan.

Quercus grosseserrata and *Q. crispula* are known in Japan by the name of "Ohnara," *Q. glandulifera* by the name of "Konara," and *Q. dentata as* "Kashiwa."

There have been imported from Japan into the United Kingdom during the last few years very large quantities of oak logs hewn square, in lengths of from 8 to 26 feet, and in widths of from 14 to 36 inches, and a small number of round logs with the bark on as felled, also boards, planks, and staves. The first shipment was in 1905, and, as is often the case with fresh timber supplies, through lack of experience in dealing with it, a great quantity was found to be very defective. By degrees, however, producers have learnt the best methods of handling it, and discounting the errors of those who have not yet learnt by experience, the quality now obtainable is of a high class.

The shipments to the Continent have now reached the enormous total of 50,000 loads per annum. This timber comes from the North Island of Hokkaidō, and is shipped from the ports of Otaru, Muroran, and Kushiro. The trees are felled between the months of November and March by men who take their supplies and camp in the forests. When the logs are hewn they are pulled by horses over the snow to the nearest railway; the frozen surface enables them to be transported over the hills and rough places.

The product of virgin forests of great age, the timber is remarkable for its extreme regularity of growth and freedom from faults. In no other oak, with the exception of the "Spessart" oak, are the yearly layers so uniform throughout the whole life of the tree from heart to bark. As the annual rings are very narrow, growth being exceedingly slow, any scantling sawn out represents a much greater age for its size than in British or other commercial oaks. For instance, in two pieces 4 inches wide, taken at random, the British showed 28 layers or annual rings, whilst the Japanese showed 81. A further examination of five more pieces of the same size gave a variation of from 62 to 93 years; it thus took 28 years to put on 4 inches of British growth in thickness, against 81 years for the same size in the Japanese wood. Many specimens of British, Continental, and American oak could be found, produced in even less time, perhaps only five or six years for the same size, whilst it would be very hard to find any of the imported Japanese oak that varied very much.

The wood is of uniformly good colour and texture, and is of slightly milder quality than the European. The trees also yield a much greater percentage of clean timber, free from knots and other defects, and the hearts are extraordinarily straight and sound. These features constitute its great commercial value.

Notwithstanding its mild nature, the wood appears to be very durable both for inside and outdoor work, either exposed to weather, as in half timbers in buildings, or on the ground as sleepers. There has not yet been sufficient time to test it thoroughly for durability out of doors, but there is reason to believe that it will compare favourably with other oaks. Used for posts, half timbers, weather boards, gates and joinery, in a building that has been under observation for about seven years, all the timber is in good condition, having indeed worn better than some other kinds exposed during the same period. Sleepers of Japanese oak laid on the Metropolitan Railway, between King's Cross and Farringdon Street, were taken up quite sound after many years, with the portion of the sleeper in contact with the ground not decayed or injured, notwithstanding the special strain of this portion of the line, where the steam and the continual change from wet to dry tell heavily on the timber. Where there was a previous indication of decay it became a little extended internally, but the general result is favourable to the durability of the wood in contact with the ground.

One of the defects of the oak of all countries is its liability to brown streaky stains running through the wood, and this is perhaps the worst defect of Japanese timber, and is no doubt due to some of it being over-ripe.

The wood shrinks a little more than some kinds of oak, but seasons more quickly, and is easier to work and fume or stain, and has a good appearance. This oak is particularly suitable for floorings, either in parquet or long boards. As the wood is mild and clean it holds its shape after planing, and being closely grained as well as elastic, the fibres are not so cut by the wear of the rough tread; and as its cost is moderate, the best and most mature timber can be used for the purpose. In Austrian or other European or American oak, on the contrary, the well-grown trees can all be utilised for making wide boards for wainscoting, and consequently realise a much higher price than is paid for floorings, with the result that immature wood and large branches are often converted for this purpose.

It is possible to obtain quite satisfactory results by seasoning Japanese oak by artificial processes. On more than one occasion perfectly fresh logs have been sawn up, artificially seasoned, and worked into panelling and fittings, which have been fixed and the whole process completed within three months, while the work executed has afterwards shown no sign of shrinkage or other fault. It is doubtful if such a proceeding could be carried out with any other kind of commercial oak with the same satisfactory results. Panelling, church seats and roofs, ship's fittings and all kinds of high-class cabinet and joiner's work, when finished, give very pleasing results, hardly, if at all, distinguishable from work in European oak (British excepted).

Many very important buildings, both in the United Kingdom and on the Continent, have been completed in Japanese oak, and the wood grows more in favour and demand every day. While relatively strong, it has not the strength of the British or some kinds of American oak, and on this account is not in favour for heavy railway waggon planks, though apart from this fact the cost of transport would prevent its competition with the kinds obtainable. Neither has it found much favour yet for staves, as *Quercus crispula* is somewhat too porous to be used for this purpose, and *Q. glandulifera* has been shipped only in very small quantities.

In addition to the timber supplied from Hokkaidō, there is an unimportant source of supply in the central district of the Main Island, on which stands the mountain of Kiso. From this source a small quantity of boards and planks was sent to London in 1914. The species is the same as that of the North Island, but in appearance it is of a pinker shade. The wood also is a little harder, and the medullary rays are bolder and larger. This wood was found to be pierced by small holes slightly wider than the head of a pin, which had been made by insects boring through the trunks of the trees. These worm-holes are seldom, if ever, to be found in the timber from the North Island, and recall those so prevalent in American oaks, though rarely seen in others. The timber of this oak, esteemed more highly in Japan than that of the North Island, is unlikely to be shipped to the United Kingdom in any quantity.

The pores are very regular and uniform, appearing only in the spring wood, generally in duplicate in each concentric layer. The medullary rays are very strongly defined, but inclined to form curved lines from the centre to the circumference of the tree, rather than to radiate in straight lines. There is a fine secondary medullary ray strongly defined, which is also common to most, if not all, of the Indian oaks.

The following figures illustrate the increasing demand for this wood during recent years:

EXPORTS OF OAK FROM JAPAN

	1907.	1908.	1909.	1910.	1911.	1912.	1913.
UNITED KINGDOM (in loads)	..	4,349	2,933	1,928	4,745	4,245	
GERMANY (in tons)	..	..	2,168	2,275	7,236	12,883	
FRANCE (in loads)—							
Sleepers	..	58	675	379	47	..	
3½ inches and up	..	1,525	1,413	3,301	877	5,800	
1½ inches and up	..	190	102	427	338	1,134	
Less than 1½ inches	..	76	42	170	452	952	
BELGIUM[1] (in tons)—							
Logs and/or not sawn	4,600	..	..	4,618	11,685	..	
Sawn	2,278	..	..	1,250	4,707	12,708	

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[1] The figures for Belgium include walnut, which, however, does not consist of more than 5 per cent.

TOTAL IMPORTS OF OAK INTO UNITED KINGDOM

Quantity in Loads

	1908.	1909.	1910.	1911.	1912.	1913.
Russia and Germany	50,935	26,247	35,008	35,004	43,011	
Austria-Hungary	5,935	4,842	4,716	5,226	7,082	
Japan	4,349	2,933	1,928	4,745	4,245	
Canada	6,932	5,104	8,077	7,306	9,222	
U.S.A.	148,068	117,090	126,574	144,716	161,407	
Other Foreign	744	239	794	1,164	924	
Australia	561	41	208	5	8	
British Possessions	72	44	16	..	4	
Total	217,596	156,540	177,321	198,166	225,903	

Value in Pounds (Sterling)

	1908.	1909.	1910.	1911.	1912.	1913.
Russia and Germany	298,862	157,406	224,866	244,141	301,745	
Austria-Hungary	92,683	76,836	75,089	83,819	123,576	
Japan	20,524	10,640	7,148	34,208	27,091	
Canada	56,580	39,877	60,729	60,773	80,257	
U.S.A.	874,849	675,407	731,396	840,880	967,702	
Other Foreign	4,770	880	3,258	5,447	5,545	
Australia	3,517	249	1,491	56	42	
British Possessions	419	268	100	..	10	
Total	1,352,204	961,563	1,104,077	1,269,324	1,505,968	

OAK, LIVE. *Quercus virens*, Ait. Weight, 59 lbs. (Hough). North America.

Although the close observer has found planks of live oak included in the general shipments of American oak, yet so far as can be ascertained no regular supplies of the wood have been seen in this country. This is unfortunate, as the timber undoubtedly contains qualities of strength and durability, and its exceptional value should make it sought after.

It is stronger than any other known oak. My specimen is very hard; it is of a nut-brown colour, and is close and smooth-grained. Gibson refers to the former great use of this oak in the American navy, and says further: "In strength and stiffness it rates higher than the white oak. . . . It takes a smooth polish. When the wood is worked into spindles and small articles and brightly polished, its appearance suggests dark polished granite. . . . Its value as a cabinet material has not been appreciated in the past, nor have its possibilities been suspected."

The pores are not numerous; they are very smooth and clear-cut. The medullary rays are clearly defined, showing with beautiful marking on the radial section.

OAK, RUSSIAN. *Quercus pedunculata*, Ehrh., and *Q. sessiliflora*, Sm.

Russian oak is very similar to British and Austrian oak. In strength it compares rather with the former than the latter, but the detailed tests so far made give no really reliable basis on which to compare the strengths of British and Russian oak, while as a constructional timber Austrian oak does not come into question in Great Britain. Russian wainscot oak on the whole may show slightly less bold silver grain than Austrian, yet the best qualities of the former vie with those of the latter in decorative effect.

Russian oak is exported from Danzig, Libau, Memel, Odessa, Riga, and Stettin

(*a*) DANZIG OAK. Weight, 47 lbs. 7 oz.—A large quantity is imported in the form of

(1) Logs hewn nearly square, from 8 to 30 feet long and from 10 to 20 inches square.

(2) Plançons—hewn logs with very large wanes.

(3) Planks of various lengths.

(4) "Deck-deals," which are planks varying in length from 24 feet upwards (but averaging about 32 feet), in breadth from 9 to 15 inches, and in thickness from 2 to 6 inches.

(5) Staves, which are imported only in comparatively small quantities, and are used for making casks and barrels. The wood is rather brownish in colour, and is slightly harder and heavier than other Continental European oak.

(6) Wainscots. The import of wainscots from Danzig, at one time considerable, has now almost ceased, and the quality of the few shipments which have been made has much deteriorated.

In earlier times there is little doubt that a large trade was carried on in oak brought from Danzig. Mr. E. Haynes quotes from the subsidy rolls of the second year of King Henry Fourth A.D. 1400, 519 years ago (1919), an early reference to the import of "wainscots, clapholtz (barrel staves), tonholtz (wood for tuns), bow staves (arrow shafts), *righoltz (rails or spars), bords (planks), delles (deals), renus (oars), plyning bords (folding boards), masts, spars de firr (firewood spars).*" There would be a roll for London, and others for principal ports. The one for the ports of the Humber—Hull, Grimsby, etc.—was in the Augmentation Office, London, a century ago, and may now be in the Record Office. In 1827 Charles First, F.S.A., published "notices relative to the early history of the town and port of Hull," in which as an appendix he printed this Hull and Grimsby subsidy roll, saying: "It is a document of singular interest as a mercantile record." The enrolment is in the Latin of the period. "The number of wainscots landed is amazing, which, with the low values, even with the then high value of money, suggest they were small in size." Elwes and Henry (*op. cit.* p. 342) quote thus from a note in Holinshed's *Chronicles* (vol. i. p. 357, ed. 1807): "According to Mr. J. C. Shenstone, Harrison of Redwinter in Essex, who lived in the reign of Henry VIII., was the author of this note: 'Of all oke growing in England the parke oke is the softest, and far more spalt and prickle than the hedge oke. And of all in Essex that growing in Bardfield Parke is the finest for joiners craft; for oftentimes have I seene of their workes made of that oke so fine and faire as most of the wanescot that is brought out of Danske, for our wanescot is not made in England. Yet diverse have assaied to deal with our okes to that end, but not with so good successe as they have hoped, because the ab or juice will not so soone be removed and cleane drawne out, which some attribute to want of time in the salt water.'" It is therefore clear that at these very early dates oak wainscot was imported into England. Elwes is in some doubt about the meaning of "Danske," but there is little doubt surely that it meant "Danzig." What the words "spalt" and "prickle" meant is doubtful, but it is likely that they relate to the kinder nature of the timber.

Of Danzig oak Laslett wrote: "It is of fair durability and is largely used in the construction of the mercantile ships of this country, but only sparingly for our ships of war, except for their decks, for which purpose it is regarded as a *spécialité*, as it stands well the wear and tear of gun-carriages. For planking it is much esteemed, as the grain is straight, clean, and almost free from knots. Further, it is so pliable and elastic, when boiled or heated by steam, that it may be bent into the most difficult of curved forms without showing any signs of fracture." The use of this timber for shipbuilding has now, however, entirely ceased. Moreover, it becomes each year increasingly difficult to obtain satisfactory supplies, for the quality has deteriorated. The timber is now largely used in the building of railway carriages and railway waggons.

(*b*) **LIBAU OAK.** See Riga oak.

(*c*) **Memel Oak.**—The timber is similar in all respects to Danzig oak and is derived from the same regions.

(*d*) **Odessa Oak.**—This wood is brought from Volhynia, Kieff, and the southernmost provinces of Russia, and is imported in the same manner in all respects as the Riga and Libau. During later years a very large quantity of high-class oak logs, hewn nearly square, and others, both hewn and sawn into octagonal shapes, have been imported, which have been used for railway-carriage and waggon-building and constructional purposes, as well as to a certain extent for joiners' work. A very large quantity also of wainscots of good size and high-class quality has been regularly imported. The quality of the wood is similar in colour and texture to the other Russian oak, but a little milder and softer, more nearly than the others approaching to the quality of Austrian.

(*e*) **Riga Oak.**—The oak shipped from Riga and Libau is derived from forests in the interior of Russian Baltic provinces and of Russian Poland. It is shipped as wainscot logs or billets, hewn logs (only in small quantities), and logs sawn octagonally, and also, to a limited extent, as planks, boards, and floorings. The principal trade, however, has been in wainscot billets. About twenty-five or thirty years ago Riga logs were the best obtainable, and realised the highest prices, although their sizes were small, the billets each averaging scarcely more than 18 cubic feet. The quality of these old shipments, and especially the Kieff logs, was the highest yet attained. The wood was bright, of uniform colour, close-grained, hard and firm in texture, and very durable. Laslett wrote: "It is characteristic of this oak timber that the medullary rays are very numerous and more distinctly marked than is the case with Danzig oak"; and the same authority says that "it was customary to select the logs into 'Riga,' 'English,' or 'Dutch' 'crown' qualities; or the 'brack' quality, at prices varying with the market rates. In 1875 these prices respectively were 100, 90, 80, and 60 shillings per 18 foot cube, in the order named." Kieff logs from about 1885 to 1890 cost about 120 shillings per 18 feet cube. This method of selection and of selling has long since been abandoned, although the term "crown" applied to the quality is still quoted, though more often than not incorrectly, and the logs are now sold always at so much per foot cube. Although the best modern shipments are not of the former superlative quality, it is doubtful if any other European oak, excepting British, equals this in quality or texture. Riga and Libau wainscot logs do not command so high a price as do Austrian, since their smaller size and mode of conversion involve greater waste.

The square hewn logs are used for constructional purposes in buildings, for window-sills, and in the making of railway carriages; while the planks and boards are utilised for joinery and floorings. The boards are too often cut from small immature wood or secondary trunks and branches, with the result that they are strong and inclined to warp and twist, and are not very satisfactory.

(*f*) STETTIN OAK.—The timber agrees with that exported from Danzig and Memel, since it is derived from the same regions. In recent years there has been an increased export from Stettin of hewn logs and logs sawn octagonally. This timber is mainly used in the construction of railway carriages and railway waggons.

OAK, SILKY. *Grevillea robusta*, A. Cunn. Weight, 37 lbs. Australia.

This very beautiful decorative wood is light brown in colour, and owes its name to the smooth and lustrous sheen of the figured surface. When cut on the quarter the medullary rays show in numberless flecks, displaying that figure which is known as "clash." This resembles the figure shown in live oak rather than the well-known clash shown on the radial cut in ordinary oak. A specimen made up into parquet flooring displays an admirable manner of using this wood, which would probably be highly popular if it were more generally known.

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The medullary rays are broad and very clearly defined. The pores are large but not very numerous; some are plugged.

Odina Wodier, Roxb. Weight, 50 lbs. India.

The wood is of a light yellow-brown colour, with a straight, even grain, somewhat resembling cigar-box cedar (*Cedrela odorata*). It appears to stand well without warping or shrinking. It should be useful as a substitute for plain mahogany or cedar.

The pores are small and rather scarce, and regular in position. The medullary rays are exceedingly fine and rather obscure.

Oleo Vermelho. *Myrospermum Erythroxylon*, Fr. Allem. Weight, 54 lbs. Brazil.

This beautiful decorative hardwood is of a bright red colour, and has a most delicate and agreeable scent. It has a contrary grain, consisting of hard and soft lines, and requires a sharp tool to secure a smooth surface. It strongly resembles the French satinee, and is in all respects as good, and perhaps even better. It would be very suitable for cabinet work of the Empire style, and for decorative furniture generally it would be hard to equal.

ILL, Port Blair, Andaman Islands.

The pores are small and numerous, and are generally plugged with a white glistening substance. The medullary rays are apparent, but are not very clearly or sharply defined.

Olive. *Olea europoea*, Linn. Weight, 58 lbs. 6 oz. Southern Europe.

Olive is imported in round logs varying from 4 to 12 inches in diameter, though occasionally a few pieces are somewhat larger. It is of a yellowish-brown colour streaked with darker markings of all shades sometimes verging almost on to black. A very smooth marble-like surface can be made with the tool, when the wood somewhat resembles the surface of boxwood. It is used for inlay and for small work of a decorative nature, such as the ink-stands, paper knives, and table ornaments which are commonly brought from the East as mementoes of a visit.

The pores are scarce and obscure. The medullary rays, which are very small and exceedingly fine, are clearly marked.

ORHAM-WOOD. *Ulmus* sp. Weight, 32 lbs. Canada, United States.

The name "Orham" is undoubtedly a corruption of the French "orme," elm. The wood which is commonly known under this name is a very nice quality elm, though it is neither hard nor tough enough to be useful for the purposes for which Canadian or American rock elm is usually employed. It might be described as being half-way between this and English wych elm, though it is whiter and much more mild in character. It has been used extensively in the United Kingdom for many purposes, particularly in the making of coffins. It is deserving of a better reputation than it already possesses, for it would certainly provide excellent material for decorative work, in which its low price would be a consideration.

OSSAGE ORANGE. *Toxylon pomiferum*, Raf.; *Maclura aurantiaca*, Nutt. Weight, 48 lbs. (Hough). North America.

The wood, which is imported in lengths of from 6 to 8 feet and 12 to 18 inches in diameter, is of a bright orange colour, deepening with exposure to air and light. It is rather lustrous, and very pliable and elastic. It has been used for walking-sticks and golf-shafts, though for the latter purpose it is too pliable in these days when stiff shafts are in demand. In Texas and other American states it is largely used and valued for posts, agricultural implements and waggons.

There is a strong contrast of dark and light rings in the annual growth. The pores vary considerably in size, and are filled with a bright, shining gum. The medullary rays are fine and distinct and rather irregular.

PADAUK, AFRICAN. Species unknown—probably *Pterocarpus santalanoides*, L'Hérit., or *P. angolensis*, DC. Weight, 60 lbs. 11 oz. West Coast of Tropical Africa.

A quantity of this timber was imported some years ago for shipment to America, where there was then a large demand. Of late, however, only a few odd logs mixed with consignments of other timber have arrived. With the exception of a few which were hewn square, they were round, and ranged from 16 to 36 inches in diameter. Some had the bark on, but with others this was removed. The wood is a brilliant crimson when first cut; even brighter than the Andaman species, which in other respects it closely resembles. When exposed to strong light it bleaches to golden-brown, but when the light is only moderate the wood becomes a dull plum-red shade. The difference between the Andaman and the African is then most apparent. It possesses some of the qualities of a dye-wood, and water poured upon it is quickly stained red. It is an effective decorative wood, stands well, and takes a very smooth surface from the tool. It forms a handsome flooring, and has been used for decorative panelling and furniture in America. It should be useful for the bodies as well as for the felloes of the wheels of gun-carriages, as it is strong, durable, and reliable. The salient features of its construction are similar to those of the Andaman wood, but it does not possess the strength of the latter. The colour is slightly brighter, and the pores sometimes glisten with streaks of gum.

There is also little doubt that the barwood which is imported from Africa is the same timber, though this is usually obtained from much smaller trees.

The pores are exceedingly variable in size, and are very unevenly distributed; they are plainly visible to the naked eye, and are sometimes sparsely filled with gum. The medullary rays are very fine, close and obscure, while, much more strongly marked, are seen irregular bands of white lines which follow the lines of the concentric layers.

PADAUK, ANDAMAN. *Pterocarpus dalbergioides*, Roxb. Weight, 48 lbs. (Osmaston, *Indian Forest Records*, vol. i. pt. iii. No. 1), 61 lbs., and 61 lbs. 11 oz. (my specimens). Andaman Islands.

For correct pronunciation see Burma padauk. This name is Burmese, for Burmese convicts in the Andamans seeing a tree resembling the padauk of their own country, gave it the same name, which strictly does not belong to it. Hitherto all the supplies have been provided by convict labour, and the future development of the export will depend on the labour available. (From private note of R. S. Troup.)

The colour varies from "a deep crimson, through cherry red, pink, and reddish-brown to brown" (Osmaston, *op. cit.*). If not heavily polished it bleaches to a rich golden-brown on exposure to light and air. When exposed to moderate light and well polished it retains almost its original rich crimson colour. Gamble says that it fades to much the same colour as teak. This must refer to its habit in India, where the heat is greater and the sun more fierce, as it is not found to bleach in this way in England or America. In the Andamans it is separated and classified into two sorts, consisting of what are termed "on-coloured" and "off-coloured," producing 70 per cent of the former and 30 per cent of the latter. Only about 5 per cent of the "on-coloured," however, is found to have the finest crimson colour. In both sorts the quality in strength and durability is equal. It is generally straight-grained, although containing alternate grains running different ways, which necessitates the use of a sharp tool to produce a smooth surface. A small percentage of the trees yield wood with beautiful figure, generally consisting of a narrow stripe or roe, often broken and interspersed with mottle, and presenting a handsome appearance when well polished. On this account, as well as for its rich colour, its chief value is for ornamental decorative work, furniture, and panelling. It has a very handsome appearance when used in parquet flooring. It is very strong and durable, both in exposed positions and in the ground, and is consequently valuable for constructive work.

In India, besides being used for planks and beams, it is considered the best wood for gun-carriages and wheels, and is also used for most kinds of ornamental and decorative work. Until recently the Burma species (*P. macrocarpus*) was considered to be the stronger and more durable, but Mr. Pearson says that tests carried out have shown conclusively that the Andaman wood is the stronger, and consequently the more suitable for gun-carriage and wheel work. Notwithstanding some considerable effort to bring it into favour in England, it has never until quite recently been in demand. Messrs. Jackson & Graham exhibited furniture made of Andaman padauk at Paris in 1878. The fittings in the office at 38 Trinity Square, London, as well as a handsome desk, are made of this wood and present a very attractive appearance. The offices of Messrs. Ellis & Sons, surveyors, in Fenchurch Street, are trimmed with it also, but in most places the building is so dark and the wood has been stained so much in polishing that it does not show to advantage. Messrs. Burroughes & Watts have used a considerable quantity at different times for such work as billiard-table construction, where its reliable qualities have proved it to be quite satisfactory. The seats and partitions of a few dining cars on the London and North-Western Railway have been furnished in Andaman padauk, but few people recognise it, as the wood has not been used for panels or decorative work, and the arms of the seats have become so dull and discoloured that except to the expert it is hardly distinguishable from mahogany.

Planks 30 and occasionally 40 inches wide are obtainable from different logs, but the finest broad slabs are yielded by the buttresses, which not infrequently disfigure the lower portions of the stems. Osmaston (*Indian Forest Records*) mentions the case of one such buttress which yielded wood for an oval table 12 feet 9 inches by 7 feet, which was formerly in the possession of the late Lord Kitchener.

During the war, large quantities of the timber lying in the London docks, waiting for a demand from America, were used for saddle-trees, mine-sweepers, mauls, and felloes for gun-carriage wheels. For these purposes padauk is perhaps better than any other wood available. Very strong and durable, hard and firm, it does not split, shrink, or expand with any climatic change. Immense quantities of it have been used in America for decorative panelling and furniture work. The greater part of the vast Marshall Field store in Chicago is trimmed with it, while it forms the panelling and furniture of many large public buildings, clubs, and private houses. It provides the handsome cases for a great number of pianofortes and organs, but perhaps the largest consumers have been the Pullman Car Company, who have used it for trimming dining and sleeping cars. The dull kind of polish (not french polish) used in America, or perhaps a flat coachbuilder's varnish, suits the appearance of this wood much better than the usual sticky, heavy french polish used in England.

Padauk has been called by one or two different names in America, such as "vermilion wood" and "East Indian mahogany," probably to obscure its origin. It is shipped from Port Blair in the Andamans, in large hewn logs from 10 to about 24 feet long, and about 22 to 48 inches square. The hearts are somewhat faulty, and do not generally carry the bright-coloured wood; the logs have sometimes a heavy wane.

The pores are irregular in size and position, and are occasionally seen in duplicate and triplicate. The medullary rays are very fine, rather obscure and numerous, mostly parallel and joined at right angles by wide irregular, light-coloured bands. The structure is very similar to that of the padauk found on the West Coast of Africa.

PADAUK, BURMA. *Pterocarpus macrocarpus*, Kurz. Weight, 53–59 lbs. (Troup). Burma.

In England this wood is commonly pronounced pad*oo*k, the "au" as "oo" in "hook." The correct pronunciation is pad*au*k, the "au" as "ou" in "gout." This wood is the product of the true forest padauk tree. "Trees are obtainable which will give clear pieces ranging in length from 16 to 28 feet with a centre girth of from 6 feet to 8 feet 3 inches, but larger logs are obtainable, although the difficulties of transport prevent their extraction."

The timber varies in colour from a bright yellowish-red to a dark brick-red, and is sometimes streaked with brown; its brilliancy of colour is not, however, so marked as is that of the Andaman padauk. After exposure to the air it bleaches to a dull yellowish-brown. It possesses a hard, firm texture and, like the Andaman wood, its close, contrary grain causes some difficulty in producing a smooth surface. It seasons well, but in the early stages it should not be exposed to extremes of heat and cold, or left unprotected from the wind, as this is likely to cause it to crack.

For many years, and indeed until quite recently, it has been supposed that it was stronger and more durable than that from the Andamans, but although it does possess qualities of strength and durability above most timbers, either under ground or exposed to wet and dry, Mr. R. S. Pearson says that the Andaman padauk (*Pterocarpus dalbergioides*) is now considered to be better in all respects. It is stronger than teak, but it is not particularly elastic, and according to Troup is especially suitable for "naves, spokes, and felloes of cart and carriage wheels, solid cart wheels, axles, carriage building, furniture, ploughs, harrows, and Burmese harps." It has also been used in Rangoon for paving blocks; for which purpose it is doubtful, however, if it would be suitable in England, as it is too hard and would probably prove too slippery. In England it has been used for gun-carriages, but its real value has never been fully recognised.

Photograph by G. R. Kem.

CROSS-CUTTING LOGS.

The pores are very irregular in size and position; they are generally plugged with a white gum. The fine, medullary rays are rather obscure and very irregular. At intervals they are crossed at right angles by similar light markings which appear round the concentric layers in fine, narrow, wavy lines.

PAGATPAT. *Sonneratia Pagatpat*, Blanco, and *S. alba*, Smith. Weight 53 lbs. The Philippines.

Foxworthy says that these two species are very much alike and may be identical.

The wood is hard, dense, and fine-grained. In appearance it much resembles guizo, but the grain is finer. It has never yet been imported on a commercial basis. If the difficulties and expense attending the export of such a heavy wood could be overcome, there is every reason to believe that the timber would meet with a good reception. Foxworthy reports it as "working readily, but contains quite a large amount of salt, and consequently is said to cause nails or spikes to rust quickly. . . . Air-dried wood sometimes contains as much as 1 per cent of its weight in salt."

The pores are small and irregular, sparkling somewhat on the tangential section. The medullary rays are not very strongly defined, and the texture and growth are very close.

PAHAUTEA. *Libocedrus Bidwillii*, Hook. Weight, 28 lbs. (Boulger). New Zealand.

The Board of Agriculture, New Zealand, says that this wood is of a "red colour, remarkably straight in grain, and durable. Procurable in lengths up to 30 feet and up to 12 inches wide. Used for bridge-building, telegraph posts, fencing-posts, and rails."

PÁO-ROSA. *Physocalymma floridum*, Pohl. Weight, 50–60 lbs. Brazil.

This timber is, according to *Brazilian Woods*, of a yellowish colour, with parallel rose-coloured grain. It is said also to be one of the most beautiful fancy hardwoods, but it is practically unknown in the commerce of the United Kingdom.

Parashorea stellata, Kurz. Weight, 50 lbs. India, Burma.

This handsome yellowish-brown, fairly hard wood can be obtained in squares 50 feet × 20 inches × 20 inches. It works and polishes well, and would probably be suitable for panelling. It has been used in Burma mostly for boat-building, and could be exported in quantity.

PARTRIDGE-WOOD. *Andira* sp. Weight, 85 lbs. 15 oz. Brazil.

Holtzapffel says that this wood is "sent in large planks or in round or square logs, called from their tints, red, brown, and black, and also *sweet partridge. The wood is close, heavy, and generally straight in the grain.* The colours are variously mingled, and most frequently disposed in fine hair streaks of two or three shades, which in some of the curly specimens cut plank-wise resemble the feathers of a bird. The partridge-woods are very porous; cut horizontally the annual rings appear almost as two distinct layers; the one hard, woody fibre, the other a much softer substance thickly interspersed with pores; this circumstance gives rise to its peculiar figure, which often resembles that of the palm-tree woods. Partridge-wood was often formerly employed in the Brazils for shipbuilding, and is also known in our dockyards as cabbage-wood. It is now principally used for walking-sticks, umbrella and parasol sticks; in cabinet work and turning; and . . . also for fans."

The very small pores are regularly distributed in groups, and are generally plugged more or less with gum. The medullary rays are hardly discernible on the transverse section, but show plainly to the naked eye on the radial, finer than, though somewhat resembling, the rays in beech.

Pasania or **Pasinia.** *Quercus Junghuhnii*, Miq. Weight, 41 lbs. Formosa.

In appearance this remarkable wood resembles a veritable cross between the English sweet chestnut and English oak. The colour is similar to that of the chestnut, from which it is only distinguished by the presence of strong medullary rays. The pores show on the radial section in a series of pretty, uneven lines, and improve the effect. It should be a valuable decorative cabinet and trimming wood.

The annual layers are very strongly marked, there being a very wide and distinct difference between the spring and the autumn growth. The pores are scarce and small. The medullary rays are very sparse, uneven, and irregular.

Patapsco or **Papapsco.**

For some reason which remains unexplained, this is a name given to a particular form of figured maple (*q.v*). The figure is a curly, wavy mottle with a blister, or indications of blister, without any bird's-eye being apparent.

Pau Amarello. Source unknown. Weight, 56 lbs. 3 oz. Brazil, Para.

This wood has a grain like a fine Spanish mahogany, but is of a bright rich, warm golden-yellow colour. The tint is not that of satinwood, but is more like a bright prima vera. It is used in Para for decorative cabinet work and for flooring. It has never been imported on a commercial basis, although it is such a handsome wood that it would be much sought for in furniture and decorative cabinet work of all sorts if it were known and obtainable.

The pores are very small, showing singly or grouped in pairs between very strongly marked medullary rays.

PEAR, NATIVE. *Xylomelum occidentale*, R. Br. Weight (at 12 per cent moisture), 46 lbs. Western Australia.

"A tree yielding a most ornamental dark-brown wood with a beautiful figure. It is light, and makes up into very fine furniture wood; finished with a wax surface it resembles moiré silk" (C. E. Lane-Poole).

PEAR-TREE. *Pyrus communis*, Linn. Weight, 47 lbs. 13 oz. Europe.

This wood is remarkable for its extraordinary smoothness and evenness of texture, which renders it excellent for carving, as it can be cut easily and with a sharp edge in any direction. It is a pale yellowish-red, resembling flesh colour more nearly than any other timber. Thus, if a statue were made of pear-wood it would probably be the closest resemblance to the human figure that could be produced. It is used for mathematical and drawing instruments and rules. Elwes and Henry mention its use for cogs, wood-screws, and tool handles.

It has also been used for furniture. A recent addition to the Victoria and Albert Museum is a seventeenth-century table of pear-wood from Boughton House, Northamptonshire. It is also to be seen in the form of marquetry, together with sycamore, ash, and maple, in a cabinet of pine, which, dating from the second half of the sixteenth century, is carved on the base with the rose and portcullis, emblems of the Tudor sovereigns of England.

A large trade is carried on in France and Germany in pear-wood stained black to resemble ebony, which is used extensively in the pianoforte and cabinet trades.

The pores are exceedingly fine and numerous. The medullary rays are hardly discernible with the aid of a lens (12 ×).

Pentace Griffithii, King. Weight, 50 lbs. India, Burma.

This is a light red, hard and close-grained wood, which is obtainable in quantity in squares 40 feet × 16 inches × 16 inches. It works well, and is suitable for cabinet work. In Burma it is used for boats, planking, masts, oars, and boxes.

PEROBA BRANCA. Weight, 50 lbs. Brazil.

The wood is light greyish-yellow in colour, close and fine in the grain, and not difficult to work, although possessing wide patches of contrary grain. It attains large dimensions, and is fit for employment in architecture, for furniture, and generally in the domestic arts. The tree is of straight growth, is stronger than teak (*Tectona grandis*), agrees well with iron, and is very durable. Brazilian ironclads are built with it. Its specific gravity is about the same as that of pitch pine. This is a valuable timber which should find many important uses.

The pores are very numerous and small. The medullary rays are exceedingly small and fine, but clearly marked.

PEROBA-ROSA. *Aspidosperma Peroba*, Fr. Allem. Weight, 59 lbs. Brazil.

This wood is of a pale rose colour with some darker streaks. It has a very hard, firm, close-grained texture. In appearance it much resembles the East African pencil cedar, but is very much harder. It is capable of a smooth surface from the tool. It is reported as being largely used in Brazil for sleepers, and also for furniture and floorings. It is possible that it might be well adapted for pencil-making.

The pores are exceedingly small and are scarcely discernible. The medullary rays are very fine and slight.

PERSIMMON-WOOD. *Diospyros virginiana*, Linn. Weight, 49 lbs. (Gibson). North America.

This is the ebony of America. Gibson describes it thus: "The wood is hard, strong and compact, and is susceptible of a high polish. . . . The value of persimmon depends largely on the proportion of sap-wood to heart-wood. That was the case formerly more than it is now; for until recent years the heart-wood of persimmon was generally thrown away, and the sap-wood only was wanted; but demand for the heart has recently increased. The demand for persimmon in a serious way began with its use as shuttles in textile factories. Weavers had made shuttles of it for home use on hand looms for many years before the demand came for power looms. . . . Persimmon-wood is suitable for shuttles because it wears smooth, is hard, strong, tough, and of proper weight. Most woods that have been tried for this article fail on account of splintering, splitting, quickly working out, or wearing rough. The shuttle is not regarded as satisfactory unless it stands 1000 hours of actual work. Some woods which are satisfactory for many other purposes will not last one hour as a shuttle."

Its use in Great Britain for golf heads has been continually growing, and it is hard to find a better, or even as good a wood for the purpose. Very rarely a few pieces are found that have such a handsome marking of light yellow, brown, and almost black streaks that the wood has been of great value as a veneer. In New York a table has been made of such a piece which is as remarkable as it is unique, and is the admiration of all who see it. This particular piece surpasses in its beauty any similar wood; the nearest resemblance would be found in a selection of very highly striped ebony or Coromandel wood.

A fine whitish ring which may mark the concentric growth is clearly visible. The pores are somewhat irregular in size, not large, but very uniform in position. The rays are very fine and distinct, parallel, regular, and almost equidistant.

A similar persimmon-wood of equally good quality is obtainable in Japan, but it is not imported commercially into this country.

PIMENTO. *Pimenta officinalis*, Linn. Weight, 68 lbs. The West Indies.

The timber is of a dark to light salmon colour, with a very firm, hard, close texture and a smooth surface. It is inclined to warp unless used in very narrow widths. It is principally employed for the making of walking-sticks.

The pores are exceedingly small and numerous. The medullary rays are very fine, and are indeed hardly discernible with the aid of a lens (12 ×).

PINE AND FIR. Sources various.

The softwoods of commerce consist chiefly of the following:

Pinus sylvestris	Redwood or red Baltic pine.
Picea excelsa	Whitewood or spruce.
Larix europoea	Larch.
Pinus Strobus	Yellow pine.
Pinus resinosa	Red pine.
Pinus rigida or *P. palustris*	Pitch pine.
Pseudotsuga Douglasii	Douglas fir or Oregon pine.
Abies pectinata	Silver spruce or silver fir.

The subject is one which is somewhat difficult of comprehension, both on account of the many different sources and consequent variety of the wood itself, and also of the perplexing nomenclature. Names which are in common use in England differ from those on the Continent, and even within the confines of this country vary according to locality; different names are applied to the same wood; names change with the lapse of time; and finally, names which are botanically quite incorrect are very generally employed, so that these jarring elements result in continual confusion and dispute.

To simplify these matters to some extent, reference will be made to the commonly accepted terms, which will then be referred to the name which is botanically correct.

The produce of *Pinus sylvestris* when imported as logs is called in England "fir timber" and abroad "red fir." If imported in the form of boards, scantlings, battens, deals, or planks it is called "yellow" or "yellow deal" in London and "red" or "red deal" in the provinces, while abroad it is known as "red" or "redwood."

Picea excelsa in logs is also called "fir" in England and "fir timber" or "white fir" abroad. When sawn it is known as "white" or "white deal" in England and "white" abroad.

These two woods are the most commonly used. The trade in them has been carried on for hundreds of years, for the northern countries of Europe abound in vast forests of these trees, which, having a free natural regeneration, have been able to meet the enormous demand of successive generations.

There is proof that the timber was familiar in England in the seventeenth century, for Milton wrote in *Paradise Lost*:

> His spear, to equal which the tallest pine
> Hewn on Norwegian hills to be the mast
> Of some tall Ammiral, was but a wand.

Most of the carved work in pine of the late sixteenth and seventeenth centuries, many fine examples of which can be seen in the Victoria and Albert Museum at South Kensington, was executed in this wood. Norwegian, Swedish, and Danzig pine were probably used indiscriminately. An interesting record of the early use of the wood is provided by the following accounts for the building of a partition in Glasgow Cathedral in 1713. They are quoted in a recent letter of A. M. C. to the *Timber Trades Journal*:

	£	*s.*	*d.*
To five long hundred daills and ane short hundred daills and ten daills at 15 shill. the peice	523	0	0
To sawing 210 of the said daills at 9 pound per hundred .	18	15	0
To 130 foot firr timber to the said use 14 shill. 6d. per foot is .	94	5	0
To sawing six draught long trees 125 shill. per draught is .	3	12	0
To sawing 18 draught trees at 6 shill. 8d. per draught is .	6	0	0
To Francis Stevenson, wright, for himself and servitors for wright work wrought be him in the outer and inner kirks, putting up the partition wall betwixt the outer kirk and queir (choir) and making up a broken pend and purple wall behind the wistloft, and scaffolds to the work, and sarking and lyning the spars, and taking off the lead and putting on new, and to pleasterers conforme to particular accompt	220	0	0

Documentary evidence is available to show that in 1798 the following imports were made:

Timber	**31,302**
Deals	**21,503**
Wainscot	**21,072**

The list of timber imports at the beginning of the last century is of interest.

	Russia.	Prussia.	Norway.	
1807	6,101	3,645	44,329	In Petersburgh standards.
1808	517	114	784	
1809	433	1,480	12,606	
1810	1,340	2,419	57,041	

To-day the supply, though not illimitable, is still assured, largely through the economic forestry systems of these countries.

The quality of all timber from the Baltic has, however, gradually deteriorated, a state which, it is considered, is bound to continue. Twenty-five years ago it was possible to obtain from the Baltic 75 per cent of sizes 3 ins. × 9 ins. and 3 ins. × 11 ins., the remaining 25 per cent only being of the smaller sizes, while in 1919 the produce of the forests was not of sufficiently large size to yield more than 25 per cent of the 3 × 9 and 3 × 11 size, and 75 per cent of the smaller. There is now hardly any 3 × 11 from the Swedish forests. With regard to the question of the size produced, it must be remembered that shippers would always cut the largest possible sizes from the trees, as the price increases in proportion to the dimensions.

The trade in Swedish and Finnish timber has gradually developed during the last fifty years, so that now practically every port in the Baltic Sea and the Gulf of Finland round to Gothenburg in the North Sea exports all manner of timbering, floorings, joinery, and general woodwork. The trade is so varied, and the qualities and descriptions of the wood range through such a wide field, that to attempt to describe it would require a whole book; only a brief reference to it can here be made. As has been stated elsewhere, every district produces wood containing its own peculiar characteristics. For instance, supplies from one port will excel in respect to freedom from shakes, while those from another, in the absence of sap, and the best quality from one port will hardly equal the worst from another. Generally speaking, the highest standard of quality is obtained from Bjorneborg and Kemi on the Finnish coast, and from Gefle to Sundswall on the Swedish. The wood exported from North Russia, particularly that from Archangel, Onega, Kem, and Petrograd, and latterly from Siberia, excels all other supplies both in quality and size.

The imports from Archangel and Petrograd generally have a hammer stamp on the butt ends of the planks, deals, battens, and boards; those from the Finnish ports are stencilled. It is customary to brand with a coloured stencil mark the produce from Sweden and Norway, while various other methods are adopted at the remaining sources of supply. Unless, however, all these matters are studied and continually kept under observation, such brands and markings are of little use, as that which is described as the first quality of one might not be so good as the third quality of another, while each is liable to continual variation according to changing circumstances.

PINE, BLUE. *Pinus excelsa*, Wall. Weight, 20-33 lbs. (Gamble). India.

This wood, which is also called Bhutan pine, very closely resembles yellow pine (*Pinus Strobus*), except that it has rather a reddish tint instead of the well-known yellow of that wood. The grain is straight, soft, and mild, and the timber would be suitable for all those purposes for which yellow pine is required. It is mentioned in Mr. Gamble's list as one of the woods which are available in fairly large quantities.

"The annual rings are marked by the denser autumn wood with more compressed trachoids and much smaller lumina. The medullary rays are fine, numerous, rather irregular, causing a silver-grain on a radial section. The resin ducts are scattered, fairly numerous, and prominent in all sections." (Gamble.)

PINE, CELERY TOP. *Phyllocladus rhomboidalis*, Rich. Weight, 40 lbs. (Baterden). Tasmania.

Tasmanian Timbers describes this wood as "a heavy, strong pine, of a clear yellow colour, useful for boards, internal fittings, or implements. It is very tough, and the shrinkage is so small that the general belief is that it will not shrink at all. The smaller trees furnish masts for small vessels."

PINE, DANZIG. *Pinus sylvestris*, Linn. Northern Europe.

This is generally known abroad as redwood. It is imported in square hewn logs of 8 to 20 inches in width and 10 to 30 feet in length, though these figures may at times be exceeded. It is also received in what are termed "deck deals." The specifications for these require thicknesses of 2 to 4 inches, with an average width of 8½ inches and a length of 20 to 40 feet. The following is the Admiralty specification for "deck deals":

Deck Deals.—The Dantzic deals for decks of 4 inches thick shall be cut 8 inches in breadth, and shall be 8 inches clear of sap for the greater part of their length and nowhere less than 7½ inches clear of sap, and shall be 26 to 40 feet in length, averaging not less than 33 feet. The deals of 3½ and 3 inches thick shall be cut 8 inches in breadth and shall be 7½ inches clear of sap for the greater part of their length, and nowhere less than 7 inches clear of sap, and shall be 25 to 35 feet in length, averaging not less than 30 feet. The deals of 2½ inches thick shall be cut 7½ inches in breadth, and shall be 7½ inches clear of sap for the greater part of their length, and nowhere less than 7 inches clear of sap, and shall be 25 to 35 feet in length, averaging not less than 30 feet. The deals of 2 inches thick shall be cut 7½ inches in breadth, and shall be 7½ inches clear of sap for the greater part of their length, and nowhere less than 7 inches clear of sap, and shall be 20 to 35 feet in length, averaging not less than 28 feet.

Longer deals of each thickness may be supplied, but only 10 per cent over the greater lengths shall be considered in ascertaining the required averages.

The deals of each thickness shall be delivered at each Dockyard in the proportion of not less than 70 per cent Crown quality, and the remainder Crown Brack quality. The whole shall be bright, clean, sound, yellow wood, converted in the country, of an equal thickness and square edged, and shall be clear of unsound sap, shakes, injurious knots and defects, according to their respective brands, and thoroughly air-dried before inspection.

In colour it is similar to the other pines. It is even and straight in the grain, tough, elastic, and easily worked, and moderately hard in texture as well as of light weight. It is employed for heavy timbering and general constructional work. Used as piles for piers in fresh tidal water, its life is about 16 years, while pitch pine, for instance, lasts for 25 to 30 years.

PINE, HUON. *Dacrydium Franklinii*, Hook., f. Weight, 33 lbs. Tasmania.

"The Huon pine, so called from the Huon River, where first found, is a pine which grows to a great size in the river-bottoms of the West Coast; it has a diameter of 8 to 10 feet, but the ordinary size of the tree will give a plank of from 14 to 30 inches in width and up to 20 feet in length. The wood is straight grained and heavy for a pine, of a bright yellow straw colour, and very full of an essential oil, which causes it to be almost rot-proof. When made into furniture, the oil slowly oxidises, and the wood turns to a smoky fawn colour with age. It is a splendid joiners' wood, and is especially useful for boat-planking, as the teredo objects to the essential oil.

"The supply is little more than sufficient for the local demand, but it is a timber that is well worth systematic cultivation, Huon pine being one of the most durable timbers known. It is not a tough wood, having rather a short fracture, but it steams and bends well. Some trees will cut very handsome figured panels. It has a strong and, to some people, rather a sickly odour" (*Tasmanian Timbers*).

PINE, JAPANESE RED. *Pinus densiflora*, S. and Z. Weight, 24 lbs. Japan.

This wood is known in Japan by the name of akamatsu. According to Goto there are two species of pine, which the Japanese distinguish by the names "akamatsu" or red pine, and "kuromatsu" or black pine. The former "is the most widely distributed of all the coniferous trees in

Japan, being found from the southern extremity of Kyushu to the southern portion of Hokkaidō." It is used in Japan for building purposes.

The wood is softer and lighter in weight than Baltic pine, and has the characteristic mildness of Canadian yellow pine (*Pinus Strobus*), while the grain is also similar to that wood; it is, in fact, something between the two. It is milder and softer than the Siberian pine (*Pinus mandschurica*, Rupr.). There is apparently a very large supply, but it is exceedingly difficult to obtain in clean lengths free from knots. It has been found to yield good results when used for the sounding-boards of violins.

Supplies of this wood have reached England mixed with white pine, and it has been found difficult to discriminate between the two.

The pores are very close indeed and ill-defined. The annual rings are close and regular.

PINE, KAURI, or COWDIE PINE. *Agathis australis*, Salisb.; *Dammara australis*, Lamb. Weight, 30–39 lbs. (Baterden). New Zealand.

The kauri or cowdie pine is a native of, and is found only in New Zealand. It is most plentiful about the middle part of the northern island, where there are very extensive forests of it, but it is only moderately abundant a little farther south, and towards Wellington and in the Middle Island it is only occasionally seen. Kauri pine, when used for masts, yards, etc., is unrivalled in excellence, as it not only possesses the requisite dimensions, lightness, elasticity, and strength, but is much more durable than any other pine, and will stand a very large amount of work before it is thoroughly worn out.

The duramen, or heart-wood, is of a yellowish-white or straw colour, moderately hard for pine, strong, clean, fine, close, and straight in the grain. It has a very pleasant and agreeable odour when worked, planes up well and leaves a beautiful silky lustre upon the surface, resembling in some degree the plainest satinwood. It shrinks very little, and stands well after seasoning; further, it takes a good polish. It is therefore valuable for conversion into planks and boards, and is very suitable for cabin and other fitments in ships, for joiners' work generally, and for ornamental purposes. It is also employed for the decks of yachts, as, from the regularity of its grain and the absence of knots, it has a better appearance than the Danzig pine that is commonly used. It also wears more evenly, and does not require the reconciling or planing over which is frequently found necessary if other woods are worked.

The kauri pine is generally sound and free from the defects common to many other descriptions of timber; it very rarely has more than a slight heart-shake, even in old trees; the star- and cup-shakes are also very rare. It is therefore a remarkably solid timber, and may be considered one of the best woods that the carpenter can take in hand. It will be seen also from the results of tests (see p. 361) that the wood possesses an exceptional strength in proportion to its weight and character.

The demand has increased very considerably during the last few years, and it is much to be regretted that general reports seem to anticipate a short supply in the future. It is very difficult to season this wood in the United Kingdom, and the customary calculations of time which apply to ordinary woods will be found all too little for this.

Dark rings mark clearly the concentric layers. The pores are not visible under the lens (12 ×). The medullary rays, which are only noticeable in some specimens, cause a fine, mottled appearance on the radial section.

PINE, KING WILLIAM. *Athrotaxis selaginoides*, Don., and *A. cupressoides*, Don. Weight, 22 lbs. (Baterden). Tasmania.

"The wood varies in colour from pinkish-yellow to pink. It is extremely light, and has a scent like cedar, from which it is called the 'pencil cedar' locally. After it is planed up there is a slight exudation of the resin. It is used for cabinet and joiners' purposes, and for making sculls for racing-boats. Notwithstanding its extreme lightness, it has considerable toughness and strength, and is very durable in the weather, being second only to Huon pine in this respect" (*Tasmanian Timbers*).

PINE, LONG-LEAFED. *Pinus longifolia*, Roxb. Weight, 40 lbs. for North-West wood; 40-43 lbs. for Sikkim wood (Gamble). Northern India, the Himalayas.

The wood is very similar in all respects to that of yellow pine (*Pinus Strobus*), except that it is a little harder and possesses more "pitchy" layers. It would be highly suitable for most of the uses to which yellow pine is put. As will be seen, Gamble and Pearson regard it mainly from the standpoint of its usefulness for sleepers in India. We should consider it in England far too valuable for such use, and as there is evidence that a considerable quantity can be expected, every effort should be made to supply the required sleepers in India from timbers of less value. The world's supply of pine is steadily decreasing, and for many purposes of great importance it is the only suitable timber. Gamble says: "In his hints on arboriculture in the Punjaub Ribbentrop says: 'I am convinced that this tree will yield the greatest net money return when once we begin to impregnate'; and I am disposed to endorse this, and to express the opinion that when the convenient situation of the forests, the easy reproduction of the tree, and the easy extraction of the timber are taken into consideration, it ought to be from properly creosoted long-leafed pine wood that the Indian railways should be chiefly supplied with sleepers. . . ."

"The wood is used in building houses and boats, for making tea-boxes, shingles, etc. The wood of the Sikkim trees is heavier, harder and stronger, more durable and of better general quality, than that of the north-west." Pearson also deals with this timber in relation to its use for sleepers, and adds: "The co-efficient of transverse strength, according to tests quoted by Gamble, gave 5·09 tons per square inch, while figures of other tests gave an average of 7·43 tons per square inch. It floats fairly well." Its real value, however, should be found in its suitability for joiners', cabinet, and other high-class work for which yellow pine is used in this country. This wood is one of the timbers mentioned in Gamble's list of woods which are available in fairly large quantities, and are likely to be worth trial.

The concentric layers are strongly marked. The pores and medullary rays are indistinct and obscure, the latter showing, however, through the lens (12 ×) on the radial section in a faint, almost imperceptible, ripple ray.

PINE, NEW ZEALAND. *Podocarpus dacrydioides*, A. Rich. Weight, 31 lbs. 15 oz. New Zealand.

The tree yields clean timber of long lengths and wide widths. It is of a light whitish-yellow colour in appearance, much resembling yellow pine (*Pinus Strobus*). The native name is "kahikatea." It is soft and straight-grained, and is largely used in New Zealand and Australia for butter-boxes. It is reported as not being durable for exposed work, and in its own country is liable to attack from boring insects. A very large quantity was imported a few years ago (1919) into the United Kingdom, but has given disappointing results, as it shrinks, warps, and twists to a considerable extent even after many years of seasoning. Although used experimentally for many purposes as a substitute for yellow pine and American whitewood (*Liriodendron tulipifera*), it has generally been condemned.

The concentric layers are clearly defined. The pores and medullary rays are confused and indistinct. The fibres are so soft and pulpy that it is exceedingly difficult to make a clean cut on the transverse grain sufficiently smooth to display the construction of the wood.

PINE, OREGON. *Pseudotsuga Douglasii*, Carr. Weight, 34 lbs. 2 oz. British Columbia, North-West United States.

The name "Oregon pine" is doubly inappropriate, for this tree is not a true pine (being more allied to a hemlock fir) and is by no means confined to Oregon, as it occurs also in other American States and in

British Columbia. The name has probably been given to it by those who originally wished to introduce it as a competitor with pitch pine, or, in other words, for trade purposes, a motive which is responsible for many of the incorrect names which are given to different timbers. According to Elwes and Henry, "it is known in the European, South African, and Australian markets as Oregon pine or Oregon fir, on the Pacific Coast of North America[1] as red or yellow fir, in Utah, Idaho, and Colorado as red pine, and in California is sometimes incorrectly called spruce or hemlock." It would therefore be preferable to use the term "Douglas fir," under which name it is cultivated in Great Britain.

The discovery has been made that two American species were known under the name of Douglas fir, and to both these, new specific names have been given. However, inasmuch as the commercial timber may be derived from one or both of these, the original specific name has been retained here: viz. *Pseudotsuga Douglasii.*

In its native American forests the Douglas fir is one of the most magnificent of the trees of the world. Writing in *The Hardwood Record* with reference to Douglas firs in the United States, Gibson makes the following statement: "The largest are 300 feet high, occasionally more, and from 8 to 10 feet in diameter. The average among the Rocky Mountains is from 80 to 100 feet high and 2 to 4 in diameter. The amount of timber yielded by one tree may be realised from the experience of Dr. Watney (of 'Buckholt,' Pangbourne), who was present at the felling of one in Washington Territory, U.S.A. The height of the trunk was 250 feet and that to the lowest bough was 157 feet. The following were the diameters at different heights above the ground: 83 inches at 7 feet, 65 inches at 37 feet, 52 inches at 107 feet, and 32 at 191 feet. The trunk was sawn off at a height of 7 feet above the ground (where it showed 420 annual rings) and 184 feet of its length yielded 21,905 feet of boards, and with the slabs and planks 23,503 feet converted, equalling 1958$\frac{7}{12}$ feet cube. It took nine railway trucks to convey the timber from London to Pangbourne. The timber contained practically no sap, very few shakes, but some of the planks contained dead knots. Large sections of the trunks (exceeding 7 feet in diameter) are familiar in England to those who visit Kew Gardens and the Natural History Museum, South Kensington." The Douglas fir flagstaff formerly at Kew Gardens, which was presented by the Government of British Columbia in 1861, was well known. It was 159 feet in length, and measured 1 foot 8 inches in diameter at the base and 5 inches in diameter at the small end. This is now surpassed by the new flagstaff which has been erected this year (1919). It was, like the former one, presented by the Government of

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[1] In North America the timber is known under a great multiplicity of local names.

British Columbia. The gigantic trunk towers to the height of 214 feet. The width at the base is 2 feet 9 inches, and it measures 1 foot across at the small end.

The timber occupies one of the most important positions in the timber world, and is known and used in nearly every civilised country. "No other single species in the United States or in the world equals the annual cut of Douglas fir. . . . In 1910 the lumber cut from this fir amounted to 5,203,644,000 feet" (Gibson). With the ever-decreasing number of large trees of Scots pine or Baltic pine (*Pinus sylvestris*) and pitch pine, this timber comes increasingly to the fore as the remaining source of big coniferous constructional timber, especially so in virtue of its great strength. It is imported into the United Kingdom from British Columbia and the United States, in the form of sawn logs, planks, and boards.

The wood is of a reddish-yellow colour, usually midway between yellow pine (*P. Strobus*) and pitch pine (*P. palustris*) in tint and general appearance. Americans distinguish two kinds of wood, according to whether the colour is more red or yellow, and prefer wood of the light red colour. Both kinds of wood can be obtained from one and the same trunk. In England no notice is taken of these differences. The resinous grain of Douglas fir is milder and less pronounced than that of pitch pine, but some specimens of the former are difficult to distinguish from those of the latter or of Canadian red pine (*P. resinosa*).

The uses of the timber are manifold, and as Gibson (dealing with America) wrote, "it would be easier to list industries that do not use it than those that do." When used for constructional work indoors it possesses sufficient durability for reasonable requirements. For exposed work, however, it cannot be said to compete with Baltic pine or pitch pine.

The principal practical value of Douglas fir lies in the fact that it is a timber obtainable in large sizes, logs, scantlings, and planks, free from sap-wood, objectionable knots, or other defects. The facility with which wide widths of the timber clean and free from sap-wood can be obtained, renders it valuable for internal woodwork. Yet as a joiners' wood it is not entirely free from deficiencies. The marked difference between the hard and soft grain is associated with a ridgy surface when the wood is worked. The grain is apt to rise after either polishing or painting, and this increases the expense of finishing. The wood does not require very long to season, and, after the process, is reliable and does not warp nor twist.

For floors and decks the timber should be "rift-sawn" in such a manner that the broad faces of the boards or planks are at right angles to the annual rings; for when the boards are cut with their broad faces tangential to the annual rings the grain is liable to flake out and a rough surface results. For decorative work, where variety of figure is desired, the latter type of sawing should, however, be followed.

Among many other uses the timber has been employed extensively in various countries in the making of masts and spars. In England, pitch pine or Baltic pine is preferred, but the latter cannot compete with Douglas fir in dimensions, while the former is sometimes too heavy.

Douglas fir is also used in the manufacture of railway sleepers and paving-blocks. The sawn wood opposes very considerable resistance to the penetration of creosote, and therefore requires high pressures to inject quantities sufficient to satisfy engineers accustomed to deal with Baltic pine.

Baterden, in *Timber* (p. 80), points out that Oregon pine, although "apparently more open in the grain . . . will nevertheless take in much less creosote than either pitch pine or Baltic timber, and that is rather against its use for sea work. On one occasion some Oregon logs were tanked with Baltic redwood logs; the latter took in nearly 11 lbs. of creosote per cubic foot, whilst the maximum for the Oregon was only 2¾ lbs., and the same thing applies to thin planks. On several occasions the author has made careful comparisons in creosoting this timber, and he has got 7 to 9 lbs. of creosote per cubic foot into pitch pine which has been air-drying for about three months, whilst Oregon logs dried under the same conditions and for the same period, and subjected to the same pressure in the cylinders along with the pitch pine, rarely took in more than 3 lbs. and many of them not 3 lbs. per cubic foot, and retanking and repressing made no appreciable difference in the quantity injected."

Douglas fir grows rapidly and well in suitable sites in England; magnificent specimens are to be seen, for instance, in Dropmore Gardens. Professor Groom says that though its young twigs are liable to attack by a special kind of fungal mildew, the species at present suffers from no serious attacks by either fungus or insect. In view, however, of the variability of the timber, even in its American home, far-reaching assumptions as to the quality of British-grown timber would be premature.

The annual rings are well marked, the medullary rays invisible, but the resin ducts are recognisable.

PINE, PITCH. *Pinus palustris*, Mill., and other spp. of *Pinus*. Weight, average 45·8 lbs. (Baterden). United States of America.

The timber known as pitch pine has been exported from the Southern States of America for the last fifty years and has consisted of the mixed produce of several botanical species of pine. The best of these is produced by *P. palustris*. What proportion of other sorts is included has varied according to the convenience and circumstances of the shipper. Gibson, in *American Forest Trees* (p. 43), says: "There is no precise agreement as to what should be included in the group of hard pines in the United States, but the following twenty-two are usually placed in that class." He then names twenty-one species other than *P. palustris*, among which, as far as the export to the United Kingdom and abroad is concerned, are included *P. echinata*; loblolly pine, *P. taeda*; *P. heterophylla*; *P. rigida*, and perhaps others. Laslett in 1875 gave *P. rigida* as the only source.

The practice adopted in America of indiscriminately mixing supplies which are the produce of many different species in one delivery, which has been referred to elsewhere, seems unfortunate. One consignment may be quite satisfactory and contain only a small percentage of the timber which is not desirable, another may consist entirely of unsatisfactory timber. This method is to be regretted, as it is only possible to separate the high-class article at the time of conversion. Fortunately some of the shippers do succeed in maintaining a high standard of quality in all their shipments, and have been repaid by the excellent reputation they have gained in the trade; nevertheless there have been many occasions when the buyer, who hoped to receive the high-class timber which is yielded by the produce of *P. palustris*, has found the majority of his timber to consist of the extremely inferior quality which is generally attributed to the produce of the loblolly pine (*P. taeda*). Pitch pine is a wood which is so well known that it is unnecessary to describe its appearance. Of a similar grain, much harder in texture and with strong pitchy growth, in other respects it resembles in appearance that of Scots pine (*Pinus sylvestris*).

Laslett in 1875 wrote: "The principal defects in pitch pine are the heart and cup shake." The latter often extends a long way up the tree, and it would be impossible to better this description of its defects if the timber referred to is the product of the true pitch pine (*P. palustris*). Unfortunately, since the date when this account was written, shipments have greatly deteriorated in quality and, as mentioned above, have often included the product of other species; consequently to Laslett's list must be added other defects which include open grain, coarse, sour-grown wood, large knots, and a far too great preponderance of sap, which latter is often seriously discoloured. The cutting during the last thirty years has been on such a vast scale that the forests will now no longer produce so much of the large-sized and better quality timber, which every year becomes therefore more difficult to obtain. The demand for this valuable timber has been regular and continuous and still remains so. For decorative work for churches, public buildings, and private houses it was greatly in vogue during the early Victorian era. The good qualities of the wood suffered, in common with other material, from the ugly and ungainly style then general, and although, to a limited extent, the timber is still used for decorative purposes in public buildings, it no longer is sought for for such work. For floorings, however, it still maintains a considerable reputation, although its use is somewhat curtailed as such wood is generally required to be all rift sawn. Wood so converted is wasteful and costly, and on this account floorings intended to be laid in pitch pine are often superseded by other woods.

The wood is very durable, and on this account and also because of its large size and long length, it is in great demand for constructional work, for which it is admirably suited in all respects. Used for piles on tidal water, where timber is subjected to continuous wet and dry, its life is from ten to fifteen years longer than that of Danzig or Memel pine. It would be difficult to estimate its length of life for interior construction; but provided that good material is used and the timber is well ventilated, it probably equals in durability that of any other soft wood. It is very important, however, to take every precaution to see that the timber is in good dry condition and, as far as may be possible, thoroughly ventilated. There is at least one case on record where the joists which composed the flat roof of a costly building, which was unfortunately improperly ventilated, were reduced to powder within two years of the completion of the building. There is evidence that under certain conditions pitch pine readily falls a prey to the attack of dry rot.

Among the supplies a very small proportion is occasionally found containing very finely figured wood, the logs yielding a curly and twisted grain which produces a very pleasant effect. This class of figured wood was much sought for about thirty years ago, but only for a short period, and although it is still occasionally asked for and used for these purposes, the demand has now ceased.

The timber is imported hewn and sawn square, generally without description of quality; also in planks which are described as "prime," "rio prime," "merchantable," and "square edged and sound."

Deals, planks, scantlings, and boards are imported under the terms of "prime" or "rio prime," and a small quantity, which is shipped under the description of "merchantable." Consequently the buyer of logs has to depend entirely upon his knowledge regarding the port of shipment and the reputation of the shipper, to determine what kind of quality he may receive. In supplies of deals, planks, scantlings, and boards he is also somewhat in the hands of the shipper, inasmuch as, notwithstanding the naming of qualities, a certain amount of uncertainty exists, as inferior shipments sometimes occur.

PINE, RED. *Pinus resinosa,* Sol. North America.

In America this is known as Norway pine. It is hard, relatively strong, and is very similar to Baltic pine, though of a slightly redder tint. It contains a considerable quantity of sap-wood which is usually more or less discoloured, probably due to the manner in which the timber is handled after being sawn, or to shipment being made before the wood is satisfactorily dried.

It is usually shipped in lengths of from 10 to 16 feet. The timber would probably be more in demand if it could be obtained in longer lengths, as the purposes for which it is employed in the United Kingdom generally call for wood of greater length.

PINE, RED BALTIC. *Pinus sylvestris*, Linn. Northern Europe.

From early times it has been customary to describe Baltic pine by the terms " red," or " yellow," or " timber." This last term is limited to square-hewn baulks from 7 inches up to as much as 18 inches and more square, which has been received intermittently from the Baltic for upwards of 200 years. The timber was generally used for constructional work of all kinds, but particularly for beams of heavy roof timbers, for piles and general wharf construction and, to a limited extent, for shipbuilding. Judging from specimens which have been taken from very old buildings, this timber has been found to be exceedingly durable.

Originally it was only imported in hewn squares, and in deals and planks; by degrees, however, this developed into a general import of boards, battens, deals, planks, and scantlings of all kinds and sizes. Laslett gives the figures of import in 1874 as about 3,500,000 Swedish deals, 7,000 loads of timber and 18,000 fathoms of firewood, besides a large quantity of boards for floorings.

In earlier days also there was a considerable import of Norwegian timber of the same description. The deals and planks then imported from Christiania were considered to be the finest material obtainable for joiners' work, and to the present day specifications name " joiners' work to be of the best Christiania deal." The larger proportion of this was hewn out by hand without the use of the saw. The last shipments of Christiania deals were seen in London more than forty years ago. Since this time the import from Norway has gradually become restricted to small-sized scantlings and battens, which were generally of very inferior quality. In addition to these, large quantities of prepared floorings and matchings of all sizes and qualities, including the highest class material, have been shipped from Christiania, Frederikstad, Drammen, and elsewhere. In this there is still a considerable trade.

PINE, RIGA. *Pinus sylvestris*, Linn.

The supply of this wood is similar in all respects to that of red Baltic pine.

PINE, SILVER. *Dacrydium Westlandicum*, T. Kirk. Weight, 41 lbs. (Baterden). New Zealand.

This timber has not been imported on a *commercial scale*. The Board of Agriculture, New Zealand, "reports it as yellowish-white in colour, sometimes mottled, straight and even in grain, dense, firm and compact, of great strength and toughness. Procurable up to 20 feet in length and 15 inches in width. Used for bridges, wharves, sleepers, mining-timbers, cabinet-making; also in building and joinery generally."

PINE, TONAWANDA. Source unknown. North America.

A considerable quantity of timber called by this name has been obtainable in London through Government agencies since the war began, though such a name was previously unknown in commercial usage. The timber resembles that of yellow pine (*Pinus Strobus*), or that which is known in America as white pine.

PINE, YELLOW.[1] *Pinus Strobus*, Linn. Weight, 27 lbs. 9 oz. Canada, North-Eastern United States.

The tree, known in America and Scotland as the "white pine," and cultivated in England under the name of "Weymouth pine," is indigenous only in a restricted region; the north-eastern parts of the United States and adjoining Canada, extending from Winnipeg to Newfoundland, and down the Atlantic States to Virginia. Formerly vast forests of this species abounded, and trees over 200 feet in height and 7 feet in diameter at the base of the trunk were obtainable. The ruthless felling operations of the American lumbermen, however, unaccompanied by adequate afforestation, have gravely reduced the supplies of this most valuable timber. Of later years the quality also has deteriorated, and it becomes increasingly difficult to obtain it free from knots and sap-wood. However, a considerable quantity free from defects is still available. The timber has steadily advanced in price, which eventually reached the figure of 6s. per cubic foot for the best quality. As the result of the large import of Siberian pine, the price slightly declined towards the year 1914. During the war the Timber Controller fixed the maximum price at 9s. 8d. per foot cube.

An extremely interesting handbook (*A History of the Lumber Industry in the State of New York*, by Wm. F. Fox), which was published in 1902 by the U.S. Department of Agriculture, informs us that "in 1614, the year when the first houses were built at Albany and on Manhattan Island (now the city of New York), the territory which now constitutes the State of New York was forest covered throughout. . . . New York was not only a forest State but essentially a white pine State. This valuable species was plentiful throughout the territory. . . . Many New York lumbermen still living recall giant white pines that measured 7 feet or more across the stumps and over 220 feet in height. . . . Dr. Torrey wrote in 1843: 'The white pine is found in most parts of the State. . . . Our chief extensive forests of this noble and most valuable tree are on the headwaters of the Hudson and on the rivers which empty into the St. Lawrence.' . . . The Adirondack tourist of to-day can still see in the tall trees at Paul Smith's or in the noble colonnade of white pine along the shores of Forked Lake further evidence of its extensive habitat." A quotation given in the same book from the *Ulster County Gazette* of November 13, 1799, reads:

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[1] The name "yellow pine" in the United States is not given to this wood, but to entirely different kinds of pine timbers.

> For sale. The one-half of a Sawmill. With a convenient place for building in the town of Rochester. By the mill, there is an *inexhaustible* quantity of Pinewood.

It is imported in the form of sawn boards and planks of various sizes and thicknesses, also in wide planks, with square sawn edges, sometimes termed "sidings"; also in long logs hewn square but showing waney edges. From these logs deck planks and other exceptional sizes are sawn out.

The wood is a pale straw colour, and contrasts with other commercial pines and firs by the very thin, dark, parallel lines (resin ducts) running with the grain. Strong in comparison with its weight, and very durable, it is perfectly reliable. Being a "soft pine" (as opposed to the hard pines, represented by the Scots pine and pitch pine), it is soft and easy to work, for it is also straight grained. For various indoor uses it is admirably fitted, since although it requires a longer time to season than do the majority of soft timbers, yet when properly seasoned it undergoes remarkably slight shrinkage, warping, or twisting. On this account it is favoured by engineers for pattern making. For the decks of ships this is a favourite wood, and in yielding clean, white flooring for pleasure yachts it has no rival. Yellow pine was formerly used largely for signboards, but is now sometimes replaced in this relation by less costly woods. Immense quantities are used in the manufacture of matches ("white pine" or "cork pine" matches), for which purpose it is unsurpassed.

The annual rings are clearly marked, but in contrast with the Scots pine and pitch pine the spring wood merges very gradually into the summer wood. The medullary rays are invisible.

PIQUIA. Source unknown. Weight, 49 lbs. 13 oz. Brazil.

The colour of this wood is a yellowish-brown with a tinge of red. It gives a rough, scratchy surface from the tool, showing a wide, double grain running different ways. The open pores show with rough edges, almost as in the end (transverse) grain, which latter has a beautiful appearance. There is nothing to recommend this wood for commercial use.

The pores are not very numerous, and appear like blotches of openings filled with gum. The medullary rays are exceedingly numerous, and very fine and close.

Planchonia Andamanica. Weight, 65 lbs. The Andaman Islands.

The wood, which is sometimes known as red bombwe, is brownish-red, hard, and durable, and takes a smooth surface from the tool. It is said to be suited for sleepers, for which purpose it is being tested by several Indian railways. There are fair quantities available, which will probably soon be seen in the European markets.

PLANE. *Platanus orientalis*, Linn., *P. acerifolia*, Willd. Weight, 30–42 lbs. Europe. (Sometimes known as Lace-wood).

The plane tree, so familiar to Londoners, in whose city it thrives so well despite the smoky atmosphere, produces a wood of a very pale yellow, though it may vary to light red or a greyish-blue, while at times it presents the variegated effect of a mixture of all these tints. Probably these differences in the colour are affected by the time of year in which the tree has been felled, though they may be due in some way to the soil in which it grows. The wood has an exceedingly close, tough, hard grain, much resembling maple. It is difficult to understand why it is not more largely used. There is little doubt that, if its qualities were more studied, the merits of the timber would commend it for many purposes. It could be used to advantage as a substitute for maple for floorings, as well as for other uses where maple is in demand. The Church of St. Sepulchre, Holborn, had formerly some beautiful panels of carved plane wood, dating from the seventeenth century. One of these is now in the Victoria and Albert Museum at South Kensington.

A fine plane tree can now be seen flourishing by the side of the Grand Junction Canal in London, close to the north gate of Regent's Park leading to Avenue Road. It has an interesting history. In 1874 a barge containing petroleum, while passing up the canal, exploded with a report which was heard ten miles away. The bridge and the keeper's cottage which then existed were blown away, and the plane tree was practically destroyed. Fifteen years ago the only remains of the old trunk was a dead, charred, pointed piece, which could be seen protruding through the new and vigorous growth around it. The old trunk has now disappeared and there is no longer any sign of the damage which was sustained.

Plum. *Prunus domestica*, Linn. Weight, 54 lbs. Europe.

There are many wild species of plum, but it is probable that the timber is more or less similar in each, and only differs according to variation of environment.

It is a very handsome wood, which is not valued as highly as its undoubted qualities deserve. It is reddish-brown, with darker and lighter streaks of the same colour, and is occasionally varied by some yellow. It is capable of a very smooth surface from the tool, and has a close, firm, hard texture. For cabinet work, inlay, and turning it would be difficult to surpass. Laslett says it has been used for pipes. It was also one of the decorative woods used in Tunbridge ware. No tree trunk should ever be wasted or burned, as it too frequently is in this country.

The pores are very small and obscure. The principal medullary rays are very clearly defined and vigorous, interspersed with numerous secondary rays of very varying size. These show in small and numerous flecks on the radial section.

Plum, Black. *Eugenia Jambolana*, Lam. Weight, 48 lbs. (Troup). India.

Of this timber Gamble writes: "Wood, reddish grey, rough, moderately hard, darker near the centre, no distinct heart-wood. . . . Five sleepers laid down on the Oudh and Rohilkhand railway in 1870, and taken up in 1875, were found to be fairly sound and not touched by white ants. It is largely used for native building purposes, posts, beams, and rafters of houses, for agricultural implements, and for well-work, as it resists the action of water well. . . .

"Annual rings, generally marked by a line with few or no pores. Pores moderate-sized and small, numerous, frequently oval, elongated, and sub-divided, joined together in wavy concentric belts of loose pale tissue. Medullary rays fine, numerous; the interval between the rays less than the diameter of the pores, round which they bend."

Podocarpus neriifolia, Don. Weight, 42 lbs. India, Burma, Andaman Islands.

This is a soft, light, straw-yellow coloured wood, with a faint lustre after planing. Its vernacular name of "thitmin" means "prince of woods," an index of its qualities. Gamble says "it is justly esteemed in Burma, and is of considerable importance in the Andamans. . . . The wood is used in general carpentry, and is excellent to work; it is employed for oars, spars, masts, and to make tea-boxes. It seasons well and does not warp or shrink." Pearson says that it is fairly suitable for the manufacture of pencils.

The pores are very small and somewhat obscure. The medullary rays, though numerous, are so faint as to be scarcely visible with the lens (12 ×).

POHUTUKAWA. *Metrosideros tomentosa*, A. Cunn. Weight, 54–64 lbs. New Zealand.

According to the Board of Agriculture, New Zealand, the wood is "deep red in colour, heavy and compact and of great strength, exhibits great power of resistance to the teredo. Procurable in short lengths and up to 24 inches in width. Used for piles, stringers, bridge and wharf planking, and mining-timbers."

POPLAR, ENGLISH. *Populus alba* and *P. nigra*, Linn. Weight, 35 lbs. 4 oz. United Kingdom.

This is a valuable timber, which is far too little used or appreciated in this country. The colour ranges from a whitish-yellow to grey; in some cases it is nearly pure white and compares favourably with rock maple. It is capable of a very smooth surface from the tool, and possesses a fine, close, hard, tough texture which especially fits it for a great many important purposes. It is easy to work, and according to Holtzapffel it is "suited for carving, common turnery, and works not exposed to much wear." It has also been used largely by toy-makers, and to a certain extent for cabinet work, and for brake blocks for railway waggons.

The famous "Inlaid room" at Sizergh Castle, Westmoreland, which dates from the sixteenth century, is of oak inlaid with poplar and bog oak. The white poplar wood against the contrasting black of the bog oak has a most effective appearance, set as it is in a groundwork of English oak. A reproduction of the room can be seen in the South Kensington Museum.

During and since the war this wood has been used somewhat extensively for the spars and ribs of aeroplanes and for other purposes in aeronautical construction, one pilot at least considering it as good as, if not better than, any other timber. It has also been used as ply-wood in the same kind of work.

Both pores and medullary rays are so exceedingly fine that they are difficult to see even with the lens (12 ×).

POPLAR, GREY. *Populus canescens*, Sm. Weight, 31 lbs. Europe.

This is a very fine timber of much more value than it is popularly supposed to possess. The colour is a light yellow with some dark streaks. It takes a very smooth surface from the tool and possesses a tough, close texture comparable to the medium varieties of maple. Its uses might be much more general if it were better known. For floorings it should be little inferior to maple, and it is one of the best woods for ply-veneer work. Elwes and Henry quote Smith, *English Flora* (iv. 244): "The wood is much finer than that of any other British poplar, making as good floors as the best Norway fir [pine] in appearance, and having moreover the valuable property that it will not, like any resinous wood, take fire."

The pores are very small and obscure, and the medullary rays exceedingly fine and difficult to detect even with the aid of the lens (12 ×).

Prima Vera. Source unknown. Weight, 36 lbs. 6 oz. Central America.

This wood is so little known in the United Kingdom that it is practically never named, nor is it reported upon in books of reference. It has, however, been used very freely in the United States for furniture, panelling, and general decorative work, and for railway-car trimming. As a result a small supply has come to London and Liverpool, and although apparently not identified, it has been occasionally used in the panels of some railway coaches on the principal railways. It is sometimes known in the United States as " white mahogany," which is perhaps a better name than prima vera, as in everything but colour it resembles mahogany. When first cut, it is of a pale straw appearance, darkening with exposure to light and air, to a warm yellowish-rose and much resembling satinwood. The trees are generally more or less figured, that is with a mottled or roey grain, some being very strongly marked with splash mottle of the best description. The wood stands well under all conditions and takes a high finish from the tool. For a light room, prima vera may be said to present, in general tone and colouring, a more artistic effect than satinwood, although the wood itself is not of so fine a grain. The principal defect is that nearly all the logs contain small pin-holes caused by a boring insect. These can, however, be remedied by a competent polisher.

The pores, which are small, are rather obscure, but are marked by a light ring or halo. The medullary rays are fine and not very distinct, showing very faintly and sparsely on the tangential section.

A very similar wood is supplied by a variety from the West Coast of Africa, which perhaps is identical with that called in France " white mahogany," the source of which is unknown. This wood is so similar that, as far as the general appearance is concerned, it is impossible to detect any difference. There is reason to suppose that a different form of polishing may be necessary, as is the case with all the mahoganies from the West Coast of Africa (see notes on polishing West Coast of Africa mahogany). In different specimens which present the same general appearance there is a very marked distinction in the construction. Thus in one the pores are small and scarce and the medullary rays clear and defined, while in another the pores are rather large and more numerous and the medullary rays very obscure and faint. On both, however, they show in much the same degree on the tangential section.

Pterocarpus Marsupium, Roxb. Weight, 53 lbs. Central and Southern India, Ceylon.

The chief native names of this species are vengai and bijasal. The wood is a golden-brown colour with lighter streaks, like a brown-stained satinwood, and it has a satiny lustre. The grain is smooth, firm, and close. Although it has established its reputation in Madras and at the Gun-Carriage Factory at Jubbulpore, where it has been used for gun-carriage wheels, its proper sphere is employment as a delicate furniture and cabinet wood. Warmer in tone and less obtrusive in character than satinwood, it would appeal with peculiar force to the artistic decorative artist in wood, and it is a matter of surprise that it has never yet been exported on a commercial basis. This is one of the timbers mentioned in Gamble's list as being available in fairly large quantities.

" Pores moderate sized and large, often subdivided, scanty, resinous, uniformly distributed in pale patches, which are joined by fine, white, wavy, often interrupted concentric lines ; marked on a vertical section. Medullary rays very fine, numerous, short, uniform, and equi-distant." (Gamble.)

Pterospermum acerifolium, Willd. Weight, 45 lbs. India, Burma.

The wood, which can be obtained in squares 20 feet × 10 inches × 10 inches, is reddish in colour and moderately hard. It works and polishes well, and is used for planking ; it also makes good matches and match-boxes.

PUKATEA. *Laurelia Novae Zelandiae*, A. Cunn. New Zealand.

The Board of Agriculture, New Zealand, reports that this wood is of " a pale brown colour streaked with deeper shades, often very ornamental. Procurable in long lengths and up to 12 inches in width. Excellent for furniture and also for boat-building."

PURIRI. *Vitex littoralis*, Dcne. Weight, 62–76 lbs. (Baterden). New Zealand.

This wood, called also New Zealand teak, is of a dark brown colour, and is very hard, dense, and heavy. Some experimental shipments were made on a small scale, and efforts made to introduce it for decorative, cabinet, and pianoforte work in London a few years ago, without, however, apparently very much success. It is obtainable in lengths up to 20 feet and 15 inches in width. Sir William Schlich, K.C.I.E., F.R.S., says that "puriri is the strongest and most durable of the broad-leaved trees of New Zealand."

Purpleheart. *Peltogyne paniculata,* Benth. Weight, 64 lbs. 2 oz. (fresh undried sample); 66 lbs. 4 oz. (my dried sample, Demerara). British, French, and Dutch Guiana, Brazil.

This beautiful wood is not sufficiently appreciated in England. It is of a dense, close texture, and after planing is very smooth to the touch; it is brown to salmon-red when cut, but after exposure to air and light it rapidly becomes purple in colour. The Surinam produces a more brilliant colour than that from Demerara. It is very strong and durable, and stands exceptionally well under difficult strains. On this account it has been used by French motor-carriage builders for the frames of window-sashes and like purposes. For this it is probably better than any other wood, as it is not injured by damp or the continual washing, while the fine, smooth grain assists the sliding up and down of the windows. It is used for ramrods, marquetry, and inlay and lining work, especially in French furniture, in which connection it bears a variety of names, these including "amaranthe" and "palisandre." A sample piece of this wood, labelled by this latter name, was sent to me for identification, confusion having arisen by the fact that in France the name "palisandre" usually indicates rosewood.

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The pores, which are rather small, are evenly distributed, and largely filled with gum. The medullary rays are even and regular, parallel and very distinct. The pores in the Surinam wood are larger and have scarcely any gum filling, but otherwise the structure is similar to the Demerara variety.

Pyinkado. *Xylia dolabriformis*, Benth. Weight, 81 lbs. (my specimen). According to Gamble the weights per foot cube range from 60 to 83 lbs. Burma.

This wood is also known as ironwood. It has recently been determined that the Indian species (*X. xylocarpa*), known as jamba (*q.v.*) or irul, is distinct from the Burmese species. It is exceedingly hard, heavy, strong, and durable. The logs are too heavy to float even after ringing, which makes the transport difficult and costly. When the tree is fresh cut the saw or tool will work it, though with some difficulty, but after long exposure to light and air it is said to be impossible to work. It has been used extensively in India and Burma for sleepers and constructional work with excellent results. It has indeed been suggested that the Burma railways placed obstacles in the way of exporting this timber by charging impossible rates in order to keep the supplies for their own use. A few logs and some planks and boards have been brought to London during the past few years and have found a ready market. The logs were, however, only imported at a heavy loss, as the transport was so very excessive; they were apparently mistaken for a parcel of teak logs.

T Railway, Middle Andaman Islands.

The wood is of a reddish-brown colour, hard, heavy, tough, strong, and rigid, and it frequently possesses some figure in the grain, which has

Photograph by J. H. Lace.

PYINKADO, LOWER BURMA.

the appearance of being both waved and twisted; the pores are filled with a thick, glutinous, oily substance which oozes out upon the surface after the wood has been worked, leaving a clamminess which cannot be completely got rid of even when the piece is thoroughly seasoned. This oily substance has probably a preservative property about it and may be conducive to the durability of the timber. On the other hand, this may have certain disadvantages. The wood has been known to swell after seasoning, and on one occasion when used for thin parquet flooring great difficulty was experienced in getting the wood to hold the glue. It was considered that this was possibly due to this oily substance. If, however, an exceptionally strong glue is used, the flooring is quite satisfactory and has a particularly handsome and attractive appearance.

Gamble says that it is " after teak the most important timber tree of Burma. . . . The wood is very durable, a property which it doubtless owes in great measure to the resinous substances contained in it. The resin is more apparent in the Burmese than in that grown in S. India. The chief use of the wood is for railway sleepers, large numbers of which are now cut in Burma and exported to India. It is the chief wood used on the Burma railways. It is also eminently suited for paving-blocks, and has been successfully tried for the purpose in Rangoon. Good blocks were exhibited in Paris in 1900. It is excellent for telegraph posts. The local uses are for boat-building, agricultural implements, carts, and tool handles. It is a valuable building wood, especially for piles and beams of bridges, but it has the disadvantage of being heavy and difficult to cut." Mr. G. R. Keen tells me, however, that a new saw which is now being used in India cuts the wood satisfactorily in an incredibly short time.

Laslett, writing in 1875, quoted a note by Lieut. Col. H. W. Blake, the Commissioner at Moulmein, who wrote that the wood was " heavier than water, and more indestructible than iron." He added : " There is a piece of this wood which supported a teak figure of Godama, taken from Rangoon in 1826, standing in a lake near. The teak figure has long since mouldered away into dust, but at the pillar I fired a rifle shot at 20 yards distance ; the ball was thrown back, making no penetration whatever. The wood seems hardened by time and exposure, and it is also a fact that the teredo will not touch it. The Burmans do not girdle and kill this tree as they do the teak, but fell and saw it up at once, and refuse to work it in a dry state." This wood is one of the timbers mentioned in Gamble's list of those which are available in fairly large quantities and are likely to be worth trial.

The pores, which are few in number, are rather small, and are plugged with a bright shining gum or resin. The medullary rays are numerous, parallel, visible, and very fine.

QUASSIA. *Picraena excelsa*, Lol. Weight, 35 lbs. 4 oz. Central America.

This timber is imported in small round logs, yielding boards of 10 to 11 inches in width. It is yellowish-white with a green tint, generally with more or less shade and mottle figure; the grain is fine, close, and smooth. The wood has an exceedingly bitter taste, but an agreeable scent.

The pores are rather small and not very numerous. The medullary rays are fine and somewhat indistinct.

QUEBRACHO. Source unknown. Weight, 77 lbs. (Baterden). The Argentine.

This wood, which is very hard and heavy, has an exceedingly dense, close grain, and is of a deep red colour. It is principally used for sleepers, immense quantities of which are exported.

RASPBERRY JAM-WOOD. *Acacia acuminata*, Benth. Weight (at 12 per cent moisture), 62 lbs. Western Australia.

This wood possesses a rich colour, varying from violet to crimson, with a very hard, close, lustrous grain. It has also been called "violet-wood," probably on account of its very pleasing and strongly persistent scent of violets. From a billet of this wood I turned a small ornamental box nearly forty years ago, and the scent is still apparent on opening the lid. The fragrance also at times resembles that of crushed raspberries; this fact accounts for the name given above. It is probable that when in a fresher condition the wood possesses a stronger and different scent.

It is a valuable wood for turnery and inlay, and should be more generally known. According to some authorities it is very durable and has been said to withstand seventy years in the ground as posts, though it is to be regretted that a wood of such value should ever be used for such a purpose.

RATA. *Metrosideros robusta*, A. Cunn. Weight, 45 lbs. (Baterden). New Zealand.

The New Zealand Board of Agriculture describes this wood as being red in colour, straight in grain, hard, dense, heavy, and of great strength and durability. It is procurable in long lengths and up to 48 inches in width. Amongst its uses are mentioned wheelwrights' work, the framework of railway waggons and carriages, and also machine beds and bearings.

RED SANDERS. *Pterocarpus santalinus*, Linn., f. Weight, 75 lbs. (Gamble). The East Indies, the South of India.

This wood, also known as "red sandalwood" and "ruby wood," is not so often seen now as formerly. Gamble says that the wood is "extremely hard; the sapwood white, heart-wood dark claret-red to almost black, but always with a deep red tinge, orange-red when first cut." It is imported in small round logs from about 1½ inches to as much as 8 or 9 inches in diameter, with an occasional larger piece. It is used for red dyes, turnery, and inlay. It has a strongly marked contrary grain of hard and soft texture, but is capable of a very smooth surface if thoroughly worked with a sharp tool, and when finished shows a fine, glossy, lustrous surface.

The pores are small, uneven, and generally plugged with resin or gum. The very fine medullary rays are numerous, parallel, and nearly equidistant. They are joined at right angles by very fine white bands in pairs following the lines of concentric layers.

REWA-REWA. *Knightia excelsa*, R. Br. Weight, 46–50 lbs. (Stone). New Zealand.

The timber is sometimes known as New Zealand honeysuckle.

The Board of Agriculture, New Zealand, reports of it that it is " deep red in colour, and beautifully mottled in silver grain. Procurable up to 20 feet in length and 15 inches in width. Used for house-blocks, piles, railway sleepers, machine beds, and for ornamental cabinet-making."

Baterden says that " It is often used for mantelpieces owing to its incombustible nature. It is durable when used for interior work, but will not stand exposure to variations of weather. All oily substances should be avoided when polishing New Zealand honeysuckle, as it absorbs grease and oil to the detriment of the finely-marked grain; and, moreover, varnishing is said to be a disadvantage."

RIMU. *Dacrydium cupressinum*, Soland. Weight, 34–40 lbs. (Baterden). New Zealand.

The tree is of straight growth and attains a height of from 80 to 100 feet, with a circumference of from 6 to 9 feet. It varies in shade from light yellow to chestnut-brown, with some streaks of lighter and darker colour, much resembling the so-called satin-walnut (*Liquidambar styraciflua*, Linn.), but with a much finer, closer texture. Unlike this wood, however, it stands well under all conditions, although it requires a long time to season properly. It is capable of a very smooth surface from the tool, and is excellent for mouldings and carved work, as a fine edge and finish is easily obtained with either hand or machine tool. A large quantity was imported in logs, planks, and boards about twenty years ago (1919), and remained in the docks for a long time, as it was entirely unknown and its merits were not realised. When at last it was used it was soon appreciated, and subsequently inquired for, but no further shipments have arrived.

Besides its many uses for cabinet and joiners' work, it was found to be one of the best woods for the framing of showcases for shop-fittings.

Ringas. *Melanorrhoea* sp. Weight, 42 lbs. 2 oz. Borneo.

This is the rosewood of Borneo. The wood is a deep reddish colour, having lighter and darker streaks, which give it a very pleasing appearance. It is of a fairly hard substance and close texture. It takes a beautiful smooth surface from the tool, and would have a handsome effect in decorative furniture.

According to Foxworthy, ringas has poisonous properties, so that in its native country it is said to be going out of general use; the poison is said to affect a person even after the wood is made up into furniture.

The annual layers are clearly marked with wide, uneven medullary rays and open pores equally distributed, showing a marked difference between the spring and autumn growth.

Riugan. *Pametia pinnata*, Forst. Weight, 55 lbs. Formosa.

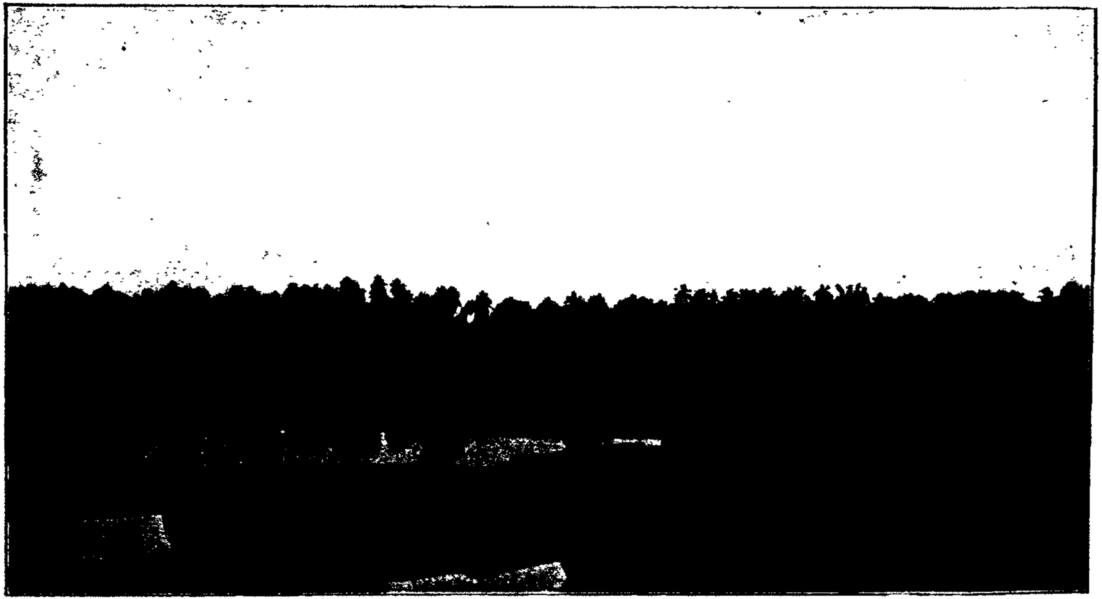
The wood is very heavy, dense, and close-grained, and is largely marked with a wavy grain. It is of a light cherry colour similar to English cherry-wood. It would be a useful timber for many purposes if regular supplies could be maintained, but so far it has not been imported commercially into the United Kingdom.

The pores are fine and glisten with bright spots of gum. The exceedingly numerous medullary rays are very fine and clean cut; they are parallel and nearly equidistant.

Rosewood, Bahia, and **Rosewood, Rio.** Also known as Jacaranda-wood and Palisander-wood. Source unknown. Weight, 54 lbs. Brazil.

According to most authorities the wood is produced from many botanical species. Amongst these Baterden mentions *Dalbergia nigra*, *Machoerium incorruptibile*, and *M. legale*. *Brazilian Woods* notes that rosewood is furnished from the three following sorts: *Dalbergia nigra*, Fr. Allem.; *Machoerium allemani*, Benth.; and *M. violaceum*, Fr. Allem. An entirely distinct wood, known in Brazil as rosewood or *Pao rosa* (*q.v.*), is the product of *Physocalymma floridum*. It should not, however, be confounded with any of the above species.

The wood is so exceedingly well known that it seems almost superfluous to describe it. Its popularity has, however, considerably diminished during the last twenty years. Indeed, except in the manufacture of pianos, it has hardly been used, though this is surprising in view of its undoubtedly high qualities. The trees produce many varying descriptions of colour and figure. The grain has a very firm, hard, and close texture; it is capable of an exceedingly smooth surface. The colour fades somewhat on exposure to light. This is not necessarily a disadvantage,



Photograph by G. R. Keen.

EAST INDIAN ROSEWOOD (*DALBERGIA LATIFOLIA*).

although perhaps an appreciation of the bleached wood is a matter of opinion.

Brazilian rosewood has been familiar as a decorative wood throughout the last century. Its popularity probably commenced with the Empire period, and in the early days of Queen Victoria's reign rosewood, used both solid and in veneer, was employed in the best cabinet work. The Bahia timber stood first for quality, while that from Rio, though less well marked and figured, produced both larger and wider pieces free from defect.

It has remained in favour more in France and America than in the United Kingdom. In the course of the last twenty years the quality of the shipments has greatly deteriorated, and a growing difficulty has been experienced in obtaining good, sound wood of a sufficiently large size to yield good veneer or panels. To this fact may be attributed some of its waning popularity. The very agreeable aromatic scent of the wood is well known.

The pores are exceedingly irregular both in size and position. They apparently vary both in numbers and size in the different concentric layers. There are irregular belts of darker coloured lines of varying widths which follow the concentric growth. The medullary rays are exceedingly fine and numerous ; they are generally crossed at right angles by somewhat similar fine white lines, thereby forming a network pattern. The radial section presents an exceedingly fine ripple ray.

ROSEWOOD, EAST INDIAN. *Dalbergia latifolia*, Roxb. Weight, 53 lbs. 11 oz. India.

This wood, which is already well known in England, France, America, and Germany, is probably not yet as sufficiently appreciated as its undoubted merits deserve. It is generally known as East Indian rosewood, or as Malabar or Bombay rosewood, in contradistinction to the older Bahia or Rio wood, which it very closely resembles. It is also occasionally termed Bombay blackwood. The logs obtainable are, however, larger and more free from defects than are the Brazilian, and are consequently of more value.

The colour is very variable, ranging from a light red to a deep rich purple, and streaked with every shade from golden yellow almost to black. The texture is close and firm, but it is generally found with a contrary hard and soft grain, which requires a sharp tool to obtain a smooth surface. It is a good wood for turnery, and stands well under all conditions. Gamble says that the chief use of the wood in India is for furniture. Rosewood gives a very handsome appearance when used for parquet floorings. In Europe and America it has been chiefly employed in the pianoforte trade, both in solid work and in veneer. The logs for veneers are either sawn or cut. They are sometimes cut through and sometimes round the logs, which are usually of such large size and good quality that the produce is very fine. The wood possesses the same agreeable scent, although not quite so pronounced, which is noticed with the Brazilian rosewood.

It is possible that the produce of *Terminalia tomentosa* (see Sain) has sometimes been confused in commercial use with *Dalbergia latifolia* and sold as East Indian rosewood.

The pores are scarce and irregular, with long fringes of very small pores in wavy lines, at right angles to the numerous exceedingly fine, parallel medullary rays.

Photograph by G. R. Kew.

East Indian Rosewood Log.

Sabicu. *Lysiloma Sabicu*, Benth. Weight, 60 lbs. 10 oz. The West Indies.

The wood is generally imported in square hewn logs, in all lengths from 8 feet and upwards, ranging from about 10 to 28 inches, but occasionally larger logs have been procurable. A cargo was landed at the West India Docks about fifteen years ago (1919), which consisted entirely of square logs of from 10 to 36 inches, and which was all most beautifully figured. The best of this was sold and transhipped to America.

The wood is of a dull brown colour, and has an exceedingly close, firm, smooth grain. A large proportion of the supplies are very highly figured, and contain both straight and broken roe, which resembles that of Spanish mahogany. The wood is tough and comparatively strong, although, according to Laslett, it is unsuitable for the beams of heavy guns lest it should contain some hidden defect, which he refers to as a cross fracture of a very remarkable kind. This is the cross break which is found to exist so largely in the mahogany of the West Coast of Africa (see p. 127). My own experience of shipments during the last twenty years, however, is that this defect is now rarely found. Sabicu exhibits a peculiarity which is shared by greenheart, in that, when tested for crushing force in the direction of its fibres, it bears the addition of weight after weight without showing any signs of yielding; but when the crushing force is obtained, it gives way suddenly and completely, nothing being left of the pieces but a loose mass of shapeless fibres.

Sabicu has very little sap and is a remarkably solid wood. It is characteristic of it that there is an almost complete absence of the heart-, star-, and cup-shakes. It seasons slowly, shrinks but little, and does not split, as do most other woods, while undergoing that process. It also bears exposure to the weather without being in any but the slightest degree affected, even if left without paint or varnish to protect it; further, it works up well and there is only a trifling loss in its conversion. It therefore has much to recommend it to the favourable notice of the manufacturer.

Formerly it was much employed in shipbuilding, where its good qualities gained for it a high reputation; to this may be attributed the fact that it is frequently specified for purposes where other and possibly less expensive woods would be equally suitable. It has also been used to a very considerable extent by the Ordnance Department for gun carriages and similar work. Till the outbreak of the European war it was considered to be the best wood for saddle-trees, but supplies then failing, substitutes were perforce employed. Amongst these was padauk, and it is doubtful as to whether this is not the more suitable wood of the two.

A certain demand exists for the use of sabicu in fine cabinet work, for which the exceeding smoothness of the grain makes it particularly suitable. It is likely that some early work which is supposed to be mahogany is of this wood. Sabicu curls or crotches, although somewhat difficult to obtain, have a very beautiful effect, particularly when employed in conjunction with satinwood, for decorative panels in the Adams and Sheraton styles. Such a combination is often found in the work of these artists. Used thus it has a most artistic appearance, for the lapse of time imparts an attractive and mellow tone to the wood.

The pores are scarce and very irregular in size and position; they generally appear in groups, and some are plugged with a bright shining gum (?). The medullary rays are exceedingly fine and numerous; they are parallel and equidistant, and are crossed at right angles by thin white lines. All the sections show pretty and delicately marked ripple rays.

SABICU, AFRICAN. Source unknown. West Coast of Africa.

A cargo of so-called sabicu was landed in Liverpool about the year 1900. The logs were all hewn square and were of large size, ranging from 18 to 40 inches square, and from 10 to 30 feet in length. Since that date a few odd logs, both square and in the round, have been received at various times.

The colour and texture of the wood much resembles that of the West Indian variety, though the grain is more open. The timber is suitable for the same purposes as those to which West Indian sabicu has been applied, and has been so used by the Ordnance Department.

Saccopetalum tomentosum, Hook., f., and Th. Weight, 40 lbs. India.

This is a very nice wood, of a light olive-yellow or brown colour, with a very close, firm, hard texture; it takes a smooth surface from the tool. The radial section is covered with tiny flecks of silver grain caused by the medullary rays. It should be a valuable cabinet wood, as it undoubtedly stands well under all conditions. Troup mentions it as being used for carving, for which it is eminently suitable.

The pores are exceedingly small; the medullary rays very strong, broad, and numerous, parallel though not equidistant.

SAIN. *Terminalia tomentosa*, W. and A. Weight, 48–71 lbs. (Gamble). India.

The colour is dark brown, rather darker than that of American walnut, and bleaches to a greyer tint on exposure; it is often beautifully streaked, and is very handsome when well polished. The grain is close, firm, and hard, rather difficult to saw and plane, but capable of a smooth surface from the tool. The wood has to be seasoned carefully. It is obtainable in large quantities, and " trees with a clean bole of 50 feet and up to 80 to 100 feet with a girth of 8 to 10 feet are common " (Pearson). This wood has never been imported into the United Kingdom on a commercial basis, but supplies on a large scale may now be expected. It is a strong timber, and can be used for all kinds of decorative and furniture work, and especially for panelling and chairs. Mr. R. S. Pearson thinks that burrs are often formed by the rubbing of trees together, and says that this is common to many Indian timbers, but is specially noticeable in *T. tomentosa.*

Sal. *Shorea robusta*, Gaert., f. Weight, 55 lbs. (Gamble). Northern and Central India.

This very valuable wood, though little known in England, is in very general use in India. The timber is hard and rather cross-grained, of a close texture and light brown colour, with small whitish sap-wood which is not durable. Gamble writes: " The fibres of alternate belts in the wood on a vertical section running in opposite directions, so that when the wood is dressed a very sharp plane is necessary or it will not get smooth; does not season well." Quoting Brandis, he continues: "The trees attain the height of 100 to 150 feet with a clear stem to the first branch of 60 to 80 feet, and a girth of 20 to 25 feet. . . . As a rule it attains to 60 to 80 feet . . . and a girth of 6 to 8 feet." In drying, superficial flaws appear and great care is needed, but when thoroughly seasoned it stands almost without a rival for strength, elasticity, and durability. Great difficulty is experienced in getting the timber out of the forests, as it will not float.

Photograph by A. Rodger.

Forest of *Shorea* sp., Upper Burma.

It is largely used in India for all purposes where durability and elasticity are required, and especially for sleepers. Pearson gives the life of a good sal sleeper as 20 years as compared with 17 to 28 years for teak (*Tectona grandis*), 20 years for pyinkado (*Xylia dolabriformis*) from Burma, and 8 months to 6½ years for jamba (*Xylia dolabriformis*)[1] from Bombay and Madras. The rail does not cut into the sal sleepers even after long use. The spike holes corrode and the spike shakes loose after continual wear. They also rust or corrode, but apparently not more than in the case of teak sleepers, though worse than jarrah. This wood holds the spikes longer and better than others. The wood somewhat resembles the so-called camphor-wood of Borneo (*Dryobalanops aromatica*), but it is harder and heavier, and would give more satisfactory results for strength and durability. It would be a very useful constructive wood in England, and if it could be obtained in regular supplies at a moderate cost its use should be encouraged. For sleepers or longitudinals for railway work it should be most valuable, as its durability is very marked, and the great difficulty experienced in the use of hardwood sleepers--that of the rail or chair cutting into the wood —appears, from Pearson's experience, to be overcome.

Photo.: Mechl. Dept. Thomason College, Roorkee.

Sal Forest of good Quality, Bengal.

The pores are of moderate size and are plugged with gum; they often appear in patches. The medullary rays are very fine and clear cut, parallel, and joined at irregular intervals at right angles by faint white lines.

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[1] Since determined to be a separate species, *X. xylocarpa* (see Jamba)

SANDALWOOD. *Santalum album,* Linn. Weight, 55 lbs. India.
S. cygnorum, Miq. Western Australia.

The wood is of a dull yellow colour, which, exposed to light and air, darkens almost to brown. It has a very close, firm texture, and has a sticky feeling to the touch. The fragrant and aromatic persistent scent is well known, being familiar in the small ornamental fancy-work which has for a long time been imported from India. Troup says that this is " the most valuable wood in India, which grows as a parasite on the roots of other plants. [It is] commonest in the native State of Mysore. The value lies in the scented oil contained in the heart-wood. . . . There is a considerable industry in the distillation of sandalwood oil from raspings of the heart-wood." He adds that it is a beautiful wood for ornamental turnery.

In Australia the extraction of sandalwood is very largely carried on. At present the wood is chiefly obtained from the roots of trees which, many years ago, were destroyed by forest fires. The Honble. J. D. Connolly, now Agent-General for Western Australia, wrote in 1911: " The export of sandalwood to the Far East, where it is used for carving images and for ornamental work, has long been a substantial industry, and in the early days the sandalwood getter was the pioneer of civilisation in many districts." Dealing with the year 1910–11, he adds that sandalwood of a value of £69,141 was exported.

The pores are exceedingly small and very numerous. The medullary rays also are very fine, and both pores and medullary rays are difficult to distinguish even with the lens (12 ×).

SANDAN. *Ougeinia dalbergioides,* Benth. Weight, 55 lbs. (Troup). India.

The wood is grey-brown and is often mottled. It is of a hard, close texture and smooth grain, and takes a good polish. It is durable and tough. Gamble says: " This very pretty and useful tree is a valuable one in India. . . . It makes excellent furniture. Roxburgh mentions that the pillars of Maharaja Sindhia's palace at Oujein are made of it."

The pores are very regular, and form a pretty pattern. The medullary rays are exceedingly fine, well defined, very numerous, parallel and equidistant.

SANTA MARIA. *Calophyllum Calaba,* Jacq. Weight, 53 lbs. Central America.

This wood is a pale reddish colour. It is moderately hard and has a fine, straight grain; it is somewhat porous. It is generally free from injurious heart- or star-shakes, has few knots, does not shrink much, and scarcely splits at all in seasoning. It is easily worked, and may therefore be considered a very fair substitute for the plainest Honduras or

Mexican mahogany. The wood stands exposure to the weather remarkably well. It was at one time used in the royal dockyards in this country, but it has not been seen in commerce for many years.

The specific gravity is about the same as Honduras or Mexican mahogany.

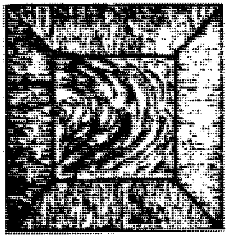
Sarcocephalus cordatus, Miq. Weight, 35 lbs. India, Burma, Ceylon.

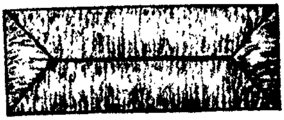
The wood is of a light grey-brown, with a soft punky grain. It could not be recommended for works of any importance.

The pores, which are not large, are numerous and regular in size and position. The medullary rays are not visible with the lens (12 ×).

SATINEE. Perhaps *Ferolia guianensis*, Aubl., or *F. variegata*, Lam. Weight, 54 lbs. French Guiana.

This valuable highly decorative wood is insufficiently known or appreciated in England, although it was mentioned by Laslett in 1875. In France, however, it has been extensively used, and is highly valued for its unusual qualities. The colour is light red, which bleaches a little and assumes a very bright lustre or sheen, especially when treated with a thin transparent polish in the attractive manner peculiar to the French artist. There is no other wood comparable to it for work in the French Empire style. The nearest approach is perhaps the San Domingo abey (*Poeppigia excelsa*), but this wood is browner in colour and does not possess the lustre in the same degree. There is always a slightly marked, very narrow shade or roe (caused by the contrary soft and hard grain), which when laid alternate ways adds greatly to the appearance of the panel or cabinet; thus:





The pores are irregular in size and position. The medullary rays, which are very fine, are exceedingly numerous and sharply defined.

SATINWOOD, AFRICAN. West Coast of Africa.

Under the above name or the names of "yellow-wood" or "greenheart" there have been imported from several ports on the West Coast of

Africa a number of logs of varying sizes up to 3 feet square. As to the source of the wood I am incompletely informed. Mr. J. J. Richardson submitted specimen leaves and wood of the tree to the authorities at Kew, who attributed them to a species of *Acacia*. Mr. Richardson was unacquainted with the native name of the tree.

The wood is greenish-yellow in colour and has a hard, smooth surface. Some is beautifully figured, so that it is valuable for furniture, cabinet work, panelling, brush-backs and the like. The timber should also be useful where strength and a certain amount of elasticity are required. Mr. George Miller has furnished and panelled a handsome room in it at Newberries, Radlett, Hertfordshire. The statement has been made that the wood endangers the health of those who work it, but up to the present (1919) only one case of illness that could be possibly associated with this timber has been reported, and even in this instance the connection is doubtful.

The concentric layers are marked by indistinct dark lines. The pores are regularly distributed, both singly and in pairs. The medullary rays are very fine and close, parallel and irregular; they show on the tangential section.

SATINWOOD, ANDAMAN. *Murraya exotica*, Linn. Weight, 62 lbs. South and West India, Burma, the Andaman Islands.

The wood is light yellow, with occasionally greyish streaks. It has been compared to boxwood, but my specimen is quite dissimilar, lacking as it does the even regularity of the colour in that wood. It is sometimes prettily figured, and would be suitable for cabinet work and for walking-sticks, and would be appreciated if it became known in this country. Gamble says that it has been tried for wood-engraving, for which it seems suitable if well seasoned.

"Pores very small, sometimes in short radial lines of 2 or 3. Medullary rays very fine, very numerous. Sharp, white, concentric lines, which frequently run into each other, unevenly spaced, roughly about 40 to 50 per inch." (Gamble.)

SATINWOOD, EAST INDIAN. *Chloroxylon Swietenia*, DC. Weight, 59 lbs. 8 oz. Ceylon.

This timber is indigenous to India, but the East Indian satinwood of commerce is obtained only from Ceylon, the quality and size being superior to the Indian wood. It is imported in round logs from 6 inches in diameter to occasionally as much as 3 feet, and in lengths from 6 to 25 feet, or even longer, the principal imports, however, being about 15 inches and up in diameter. There is a considerable similarity also between the East Indian satinwood and the West Indian (*Zanthoxylum*), but the latter is much the better wood. The East Indian is obtainable in larger widths and longer lengths, and there is a much greater prevalence of figured wood; and the cost also is less. The logs are very liable to cup-shakes and gum rings, which show in the butt ends as a thin dark-coloured line following the layer of annual growth, either partly or completely round the tree. These dark gum streaks continue through the log, and wherever they exist there is a liability, and in course of time almost a certainty, that a crack will develop. The logs are also subject to the borings of large grubs which leave holes of from ¼ inch to as much as 1 inch in size. These occur on the outside of the tree under the bark, and extend from 1 to 3 inches into the log, and reduce the proportion of convertible wood. It is exceptional to find a plain log, for nearly all yield figured wood—from a simple light and dark coloured streak or stripe, or a broken stripe or roe, to a light and dark coloured broken roe with strong mottle. Some logs are full of brilliantly marked figure, generally of small character. R. S. Troup in some private notes on satinwood, *C. Swietenia*, says: "The trade in satinwood is not nearly so important in India as in Ceylon. The tree is very common in parts of the Indian peninsula, the largest out-turn being from the Godaveri district of Madras; apparently, however, it does not reach such large dimensions as in Ceylon. According to Gamble the cause of 'figury' wood has been somewhat discussed. Mr. H. S. Hansard in *Ceylon Forester* (ii. 253) maintains that it is caused by irregular growth from the cambium; Mr. Armitage in the same paper, that it is caused by the irregular healing

Photograph by G. R. Keen.

EAST INDIAN SATINWOOD LOGS, CEYLON.

of wounds in the bark made by the Sambhar deer. I have noticed that where the satinwood grows, the deer tend to rub their antlers more on this tree than on almost any other, owing no doubt to the fact that the bark is highly aromatic." Mr. Troup concludes by doubting whether these are causes of the figury satinwood of commerce.

The timber stands well, but its use is more adapted for veneering than for solid work. In India it has been used for many purposes, including wharf piles, agricultural implements, brush-backs, carving and turning, naves and felloes of wheels, and a great variety of different work. The bridge at Peradeniya, near Kandy, in Ceylon, was constructed entirely of this wood. It contained a single arch of over 200 feet span, which has now been taken down. In England its uses have been confined to brush- and mirror-backs, small and large cabinets, and furniture and panelling. For brush-backs it is not comparable with the West Indian, as the wood does not stand the continual washing. A very handsome example of fine East Indian satinwood panelling can be seen at Lyons' Popular Restaurant, Piccadilly. In very many of the fine examples of satinwood furniture, East Indian wood has been used for linings and cross-banding, for which it is specially suitable. In some cases where it has been introduced for entire panels or table-tops in old furniture, the whole surface will be found to be one series of parallel cracks. Certain specimens of the wood are, however, quite free from this defect, and of late years it has become customary to use it more than the West Indian. It varies in colour more than the last-named, being of

Photograph by G. R. Keen.

EAST INDIAN SATINWOOD.

all shades from a bright yellow to a dark brown, sometimes of a warm golden colour, with a satiny lustre. The wood possesses the same scent as the West Indian though in a diminished degree. The concentric layers show in a similar manner to the West Indian (*Zanthoxylum*), except that there is a greater variety in the lighter and darker streaks.

The pores are very regular and evenly distributed and the medullary rays clearly defined, parallel, and joined at irregular intervals by similar white lines running at right angles. In all respects except colouring it is remarkably similar to, and has all the characteristics of, the West Indian wood.

Photograph by G. R. Keen.

A VERY FINE LOG OF FIGURED EAST INDIAN SATINWOOD,
18 FEET BY 9 FEET IN GIRTH.

The figure can be clearly seen on the butt end.

SATINWOOD, WEST INDIAN. *Zanthoxylum* sp. Weight, 51 lbs. 13 oz. The West Indies.

The finest satinwood, both in quality and colour, has been imported from Porto Rico, but supplies of good-sized logs have almost ceased, and most of the best wood of late has come from San Domingo. A small number of logs of good quality and colour have come from another island recently, the origin being kept secret for trade reasons. Small-sized wood of good quality and colour has been obtained from Jamaica in limited quantities.

This very beautiful, decorative cabinet wood was appreciated at an early date by the most artistic furniture designers and makers, who have left to posterity a great many magnificent specimens of their art executed mostly, if not wholly, in West Indian satinwood. Adams, Sheraton, and Hepplewhite have all stamped this wood with their art and their art with this wood. The work has sometimes been varied by the use of bandings or linings and, in a few instances, with whole panels of other decorative woods. Satinwood and sabicu produce a happy combination of colour which particularly suits this type of furniture. Probably even these great artists never imagined that the colour of the wood that they used would mature to such a lovely tint as that assumed by satinwood after 100 or 150 years. This is a golden-yellow rose colour with a bright, satiny sheen which cannot be obtained by any artificial means, or equalled by any other wood.

The logs range in size from about 7 inches to 24 inches in diameter, and are generally manufactured in oblong pieces with nearly square edges. Occasionally some are found even larger, but anything over 18 inches is now very rare. I have a beautifully figured piece composing a table top, which measures 28½ inches wide by 4 feet long, and is all cut on the quarter, entirely free from heart. This was probably from a log grown all on one side, but which even then must have been fully 4 feet in diameter and probably more. The plainer logs are used for such work as sides, rails, styles, and mouldings, and for legs of cabinets; while a very small number of figured logs are also used for ornamental brush- and mirror-backs. Nearly all the figured wood is converted into veneers for highly decorative furniture and panelling. Such logs command very high prices indeed, the record being about £18 per cubic foot for a squared log, and £150 per ton for a root of Porto Rico wood. Of late years a considerable number of roots of trees have been brought from Porto Rico, most of which have been used for ornamental brush- and mirror-backs; a few, however, have provided some magnificently figured specimens of veneers, about 20 to 30 inches long, and ranging from about 8 inches in the narrower to 15 inches in the broader parts. These irregularly shaped pieces, when matched up, form very handsome table tops and panels.

The colour of the Porto Rico wood is usually richer than that of other varieties, although some of the logs imported from the unknown source have equalled the best Porto Rico wood. Generally, however, all other varieties are of a paler shade. The colour continues to deepen and improve with exposure. There is a strong and pleasant scent in the wood which resembles that of coconut-oil. Logs kept for a considerable time are liable to split with heavy side shakes, but when converted this risk disappears, and in this respect the wood shows a marked superiority over East Indian satinwood (*Chloroxylon Swietenia*).

The medullary rays are strongly marked, and are uneven and irregular, showing slightly on the radial section as in sycamore. They are joined

Photograph by G. R. Keen.

SATINWOOD LOGS, CEYLON.

at right angles by somewhat similar white lines, making an uneven oblong pattern of various sizes. The pores are scattered, numerous, and fairly regular; they are generally filled with gum.

Schima Wallichii, Choisy. Weight, 44 lbs. India, Burma.

This wood is reddish, fairly hard and tough, durable but apt to shrink and split unless carefully seasoned. The tree is fairly common, and a good quantity of timber can be obtained in squares 25 feet × 10 inches × 10 inches. It is suitable for such work as bridges, building, and planking.

Schrebera swietenioides, Roxb. Weight, 57 lbs. (Gamble). India.

This wood is described by Troup as "brownish-grey, hard, close-grained, no definite heart-wood, but irregular masses of purple or claret-coloured wood in the centre, and scattered throughout the tree; durable and of good quality. Used for ploughs, weavers' looms, utensils; possible substitute for boxwood for engraving." My specimen, taken from a trunk sent over specially, is, however, a uniform yellowish-brown colour, like a rather dull satinwood (*Chloroxylon Swietenia*). There is no trace in the log of any other colour. The wood is smooth and close-grained, but it is not, however, according to the specimen to which I have referred, suitable for engraving, as Troup suggests. It should rather be employed for cabinet and decorative work, for which its artistic appearance would recommend it.

The pores are regular and small. The medullary rays are also regular, parallel, and unusually thick, showing plainly to the naked eye on the transverse section.

SEQUOIA. *Sequoia sempervirens*, Endl. Weight, 25 lbs. 5 oz. Southern Oregon to Central California.

This timber is called sequoia in England and redwood in America. It should not be confounded with the timber of the big tree (*Sequoia gigantea*), which is not generally known in commerce. The trees are of immense size, and yield exceedingly wide planks, which if necessary can be obtained up to, or possibly over, 6 feet in width. When the merits of this wood are considered, it seems strange that the demand is not more general. It can be obtained free from defect in larger sizes than any other timber, is easily worked, capable of a smooth surface from the tool, stands exceedingly well, is of an agreeable colour, and very durable both indoors and where exposed to the weather, and it can be procured at low cost.

The colour is a dull brick-red, deepening and improving in tone with age and exposure. The timber is generally straight-grained, and similar in its style of marking to that of most pines, but it is possible to find trees possessing curly and wavy figure, and sometimes having burrs. Some of the colour can be washed out of the wood if it is exposed to the rain and wet, as with African padauk; and Gibson says: "This colouring matter, when washed out in large amounts in the process of paper-making, has been manufactured into fuel gas."

Although soft, the timber dulls the edge of the tool, and its uses are those in which hardwoods are usually employed. It splits easily, but so does the hardest oak. It makes very good and handsome panelling, and is not too soft for this purpose. It is strong enough to be used in America for shingles, all sorts of joinery work, sleepers for railways, and paving blocks. In all these it is satisfactory, and the wood is so strong and durable that, according to Gibson, when the sleepers are worn out the rejected worn ties (sleepers) are gathered up by thousands and used for fence posts. It is deceptive in regard to its qualities of seasoning. However long it may have been drying, the wood, when cut, gives the impression that it is not properly seasoned, yet with less period allowed for drying than might be expected to be necessary it has been found to stand in places where other timbers would have failed. A short time ago some work was required to be carried out in sequoia, and it was found that wood seasoned for any length of time was unobtainable. The work had to be completed with wood which the workmen did not consider to be seasoned, yet it was found that no shrinkage occurred, although part of the work included a mantelpiece and overmantel of a fireplace, where even thoroughly seasoned wood of other sorts will sometimes fail. It has been used extensively for shipbuilding work, for fittings and pattern-making. The late Mr. Wilberforce Bryant had a much-admired room at Stoke Poges panelled with sequoia. As it is not liable to shrink, and is obtainable in very wide widths, it is very suitable for signboards and panels of all sorts. Reference is made elsewhere to the common idea that all timbers, if used for decorative work, should be french polished, and perhaps the fact that this wood does not take kindly to polish is one of the reasons that it has not been more commonly used. If, however, the work is treated instead in a way suitable to its appearance, very satisfactory results can be obtained.

The wood has been recommended for pencil-making. There is no evidence to show whether it has given satisfactory results, but it would be desirable to make experiments, as a substitute for pencil cedar (*Juniperus virginiana*) is much required.

The annual rings are clearly marked by a dark band of stronger grain, and are very irregular. The tree generally makes large growth in early life, growing more slowly at a later period; the annual growth in both early and later life varying considerably from year to year. The medullary rays are clearly marked, and are parallel on the transverse section. They stand out from the soft grain, giving, with the concentric layer, somewhat the appearance of a miniature honeycomb. When cut on the quarter, these concentric rings appear like thin red stripes, much darker than the general colour, and the medullary rays are strongly marked, as in the plane tree. The open pores shine brightly all over the surface with specks of gum.

SERAYAH. *Hopea* sp., or *Shorea leprosula*, Miq., or *S. parvifolia*, Dyer. Weight, 22 lbs. 2 oz. Malay Peninsula, Borneo.

The product of this tree has been imported from the Malay Peninsula, Borneo, and from Singapore, mostly in sawn square planks and boards, and a few logs hewn square. The converted pieces have been cut out free from all defect, and the wood has been called by a variety of names such as East Indian mahogany and East Indian cedar, as well as by its proper name of serayah. It is light in weight, and so similar in colour and appearance to Gaboon mahogany (*Boswellia Klaineana*) that individual pieces when planed can hardly be distinguished from it by the naked eye. The section end, however, shows some degree of difference. A considerable variation has been found in different shipments in texture, quality, and weight, but it is all very liable to warp and twist, and this timber should never be used in any position where it is not fixed and tied down. It is a good substitute for mahogany in cheap work, or for cheap cigar-boxes, but the grain is of a woolly, spongy nature, and it is difficult and costly to obtain a smooth finish from the tool.

The annual layers are strongly defined, the pores are irregularly placed and uneven in size. The medullary rays are confused and ill-defined, but show very strongly on the radial section as in sycamore and beech.

SERVICE-TREE. *Pyrus torminalis*, Ehrh. Weight, 39 lbs. 13 oz. Europe, North America.

The wood is hard and close-grained, with a smooth texture, and is of a yellowish-red with lighter coloured streaks. Elwes and Henry say it "is unknown as a timber tree in the trade, owing to its scarcity. Evelyn says that 'the timber of the sorb is useful to the joiner, of which I have seen a room curiously wainscotted; also to the engraver of wood-cuts, and for most that the wild pear tree serves.'"

The numerous pores, which are very small, are quite regular. The medullary rays are hardly discernible even with the aid of the magnifying lens (12 ×).

SHE-OAK. *Casuarina Fraseriana*, Miq. Weight, 52 lbs. Western Australia.

The colour of this wood is a light reddish-yellow; it has a smooth, hard texture which is somewhat comparable with live oak. The medullary rays show very strongly in a series of large-sized flecks or splashes. It is a handsome wood for decorative cabinet work, and was so used rather extensively in this country during the latter part of the nineteenth century. For many years, however, there has been no import on a commercial basis. Lane-Poole says that " it splits well and was used almost exclusively in the early days of the colony [sic]. for roofing shingles. A shingle taken from one of the first erected houses in Perth (after eighty-three years' use) was found to be in a splendid state of preservation."

SHIRA-GASHI. *Quercus Vibrayeana*, Fr. and Sav. Japan, Formosa.

According to Goto " the several varieties of kashi (oak) are the most widely distributed of the broad-leaved evergreens." Ubame-gashi (*Quercus phyllireoides*, A. Gr.) " is white with a shade of yellow, and the hardest and heaviest of all timbers produced in Japan. Is used in house-building where hardness and strength are required, but the chief use is in charcoal-making." The same author classes Ichii-gashi (*Quercus gilva*, Bl.), Shira-gashi (*Q. Vibrayeana*, Fr. and Sav.), Aka-gashi (*Q. acuta*, Thunb.), in the same category with Ubame-gashi. The European supply of Japanese oak is produced almost exclusively from *Q. grosseserrata* and *Q. crispula* (see page 192), with a very small supplement of *Q. glandulifera*, Bl.

Shira-gashi is a hard, very dense, close-grained timber. The colour is a warm brick-red with dark streaks, not unlike the rich red colour of some British brown oak. It is somewhat like American red oak (*Q. rubra*), though browner and of a more pleasing tone. The texture of grain and appearance of the medullary rays are exactly similar to the European evergreen oak, as also is the characteristic liability to diagonal splits. The wood resembles that of *Q. gilva*, except that it is even harder and heavier. None of the above species named—that is, of evergreen oaks—has ever been imported on a commercial basis.

The pores are small and very scarce, nearly always following an irregular single line. The medullary rays are very numerous, and stand out thick and conspicuous to the naked eye. They are crossed at right angles by exceedingly fine parallel lines (? of parenchyma).

SICUPIRA AMARELLA. *Bowdichia nitida* Brazil.

This is described in *Brazilian Woods* as " a wood of the first quality for framework and building."

SISSOO. *Dalbergia Sissoo,* Roxb. Weight, 48 lbs. India.

The timber of sissoo is probably unknown to any but those possessing an intimate knowledge of India and its forest wealth. Yet sissoo is one of the most valuable of timbers, and in its qualities practically unique. The grain is so remarkable that the native craftsman can work the most delicate and intricate carving to a depth which the European would probably believe to be impossible of achievement in any wood. The native princes in India possess works of this character which would astonish the craftsmen of this country who have not previously been familiar with the wood and the native workmanship.

The colour is a rich warm brown, sometimes having golden or deeper brown streaks, and darkening on exposure. The texture is firm, hard, and compact. It is very strong and durable, and seasons well without warping, twisting, or splitting, while it takes a beautiful polish. It is extensively used in India for a variety of purposes. Gamble says: " As a furniture wood and for carving, it is probably the finest wood in India; while with regard to its durability and strength as a wood for wheels, Clifford says: ' The wheels of our ordnance carriages have never failed, however arduous or lengthened the service has been on which they have been employed, of which no more striking example can be furnished than the campaign in Afghanistan, about the most trying country in the world for wheels. Some of our batteries served throughout the campaign, went to Bameean and even to the Hindoo Koosh, and came back again to India without a breakdown, while Royal Artillery wheels, built of the very best materials Woolwich could produce, specially for Indian service, almost fell to pieces after a few months' exposure and service on the plains of India.' " Sissoo gives a very handsome appearance when used for parquet flooring. If a regular supply of this timber were forthcoming it would become an assured success.

The pores are scarce, the larger connecting with a ring of smaller, and making a handsome ripple pattern on the transverse grain. The medullary rays are very fine, numerous, and parallel, and are crossed at right angles by similar white lines.

SNAKEWOOD. *Brosimum Aubletii,* Sw. Weight, 77–83 lbs. (Stone and Freeman). British Guiana.

This is also called letter-wood. It is imported in short round logs from about 3 to 6 feet long and about 3 to 7 inches in diameter with the sap-wood cut off. The wood is very hard, dense, and close-grained, and is rather brittle; it is generally of a faulty description, and supplies are growing more scarce. The colour of the heart-wood is a deep bright red, which darkens on exposure. It is more or less marked with dark or black rings and spots, which, resembling the marking of a snake, accounts for its name. It is principally valued for use for walking-sticks, well-marked pieces suitable for this purpose realising, especially in Paris and New York, very high prices. It is also used for handles of umbrellas and parasols, for inlay work, bows for archery, and fiddle bows. The sap-wood is of a bright light yellow colour, and Stone (*Timbers of Commerce*), suggests that it might be used as a substitute for boxwood. So far, however, the sap-wood has not been imported.

In a private note B. Bradley speaks of letter-wood as being a different species, " not so good."

The pores are very scarce and exceedingly small. The medullary rays are numerous and variable; some which are very sharp and prominent have fine, small secondary rays running between them.

SNAKEWOOD, INDIAN. *Strychnos colubrina*, Linn., and *S. Nux-vomica*, Linn. India.

These woods are not important, and are not encountered in ordinary commerce in the United Kingdom.

SNEEZEWOOD. *Pteroxylon utile*, Eck. and Z. Weight, 65 - 75 lbs. South Africa.

This wood, valuable as it is for its great durability, is so fully appreciated and utilised in its native country that it is unlikely ever to have much commercial importance in the United Kingdom. In common with some other timbers, though in sneezewood probably in a greater degree than any, the dust from the wood causes sneezing, which is, of course, the origin of the name.

SOPHORA. *Sophora japonica*, Linn. China, Japan.

This wood is known in Japan as yen-ju or en-ju, and has a close, firm, hard texture with a somewhat interlocked grain. Elwes and Henry say that " the wood, according to Shirasawa, differs remarkably in the colour of the heart-wood and sap-wood. It is tough and durable, though light and coarse-grained; and the annual layers are marked by broad bands of open cells. In Japan it is used for the pillars and frames of their wooden houses."

Spondias mangifera, Pers. The Hog Plum. Weight, 26 lbs. India, Burma, Ceylon, Andaman Islands.

This is a soft and spongy greyish-white wood, of which one of the vernacular names is " tongrong." The timber is of little, if any, commercial value.

SPRUCE. *Picea excelsa,* Link. Weight, 36 lbs. 6 oz. Europe, Canada, United States.

This timber, if imported from the Baltic, is called " white fir," " white deal," or " white," but if from Canada or the United States, the name " spruce " is used. It would be preferable to use the correct term " spruce " for the produce of all these countries.

The wood is white, and straight and even in the grain; it is tough, elastic, and light, and more difficult to work than pine, chiefly owing to the excessive hardness of the small knots which are frequently found in it. These are generally blackish, or they are surrounded by a black ring, and often form the only means of distinguishing the wood from the so-called " yellow deal " (*Pinus sylvestris*). The Baltic spruce is milder and easier to work than the Canadian or American; some of the latter is exceedingly tough and hard to saw and plane. When cut into deals it is somewhat disposed to warp, unless it is carefully stacked in the places where it is stored during the process of seasoning. The shrinkage is inconsiderable and the sap-wood, though generally only of moderate thickness, is rarely noticeable, while if it is distinguishable, the reason generally is that the timber has been allowed to get rain-wet before drying.

The trees are generally straight, and being strong, as well as elastic, they are admirably suited for making the small spars required for ships and boats. They are also in great request for ladders and scaffold poles. The timber is useful for all kinds of interior joiners' work, and in the simpler forms of furniture and articles of domestic offices, such as cupboards and tables. For these purposes the only objection is that, notwithstanding the use of the best varnish or paint, the mark of the hand- or machine-plane shows through more than in the yellow deal, or other similar woods. For timbering work indoors its life is probably slightly less than that of yellow deal. In this connection it may be remarked that it is strange that whereas architects and engineers will not allow its use for this work in London or the south of England, it is common to specify and use it in Liverpool, the north-west districts, and in Scotland. For constructive work out of doors, however, or where strength is required, it should not be used, as when exposed to the variations of the weather it soon decays; on one occasion the collapse of a large staging, constructed in this wood, formed to seat people to witness a ceremony, resulted in considerable casualties.

Used as sleepers, spruce has proved to be quite satisfactory. A letter from Mr. E. Trench, of the London & North Western Railway, dated July 23, 1919, reads: " . . . the sleepers . . . were laid in the Ingleton[1] Branch in 1886 and 1887, and the great majority of them are still on the road. These sleepers were invoiced as "spruce," and probably many of them were spruce, but I am not in a position to say that they all were, and it is difficult now to identify the timber. They were purchased from the Duke of Buccleuch, and were grown in Dumfriesshire."

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[1] Yorkshire.

The concentric layers are clearly marked by a dark ring. It is impossible to see either pores or medullary rays under the lens (12 ×), but the rays show very finely as faint flecks on the radial section.

SPRUCE, HEMLOCK. *Tsuga canadensis*, Carr. Weight, 36 lbs. Eastern North America.

Gibson describes the wood as follows: "The wood of hemlock is soft, light, not strong, coarse and crooked grained, difficult to work, liable to windshake, splinters badly, not durable. The colour of hemlock heart-wood is light brown, tinged with red, often nearly white. The sap-wood is darker. . . . The physical characteristics of hemlock are nearly all unfavourable, yet it has become a useful and widely used wood. It is largely manufactured into coarse lumber and used for outside work—railway ties, joists, rafters, laths, etc. It is rarely used for inside finishing owing to its brittle and splintery character. Clean boards made into panels or similar work, and finished in the natural colour, often present a very handsome appearance, owing to the peculiar pinkish tint of the wood ripening and improving with age. With the growing scarcity of white and Norway pine, hemlock has become the natural substitute for these woods for many purposes. . . . In 1910 hemlock lumber was cut in twenty-one States, the total output exceeding 2,500,000,000 feet.

"Hemlock possesses remarkable holding power on nails and spikes, and that is one reason for its large use for railway ties. It does not easily split, and there is no likelihood that spikes will work loose; but the wood decays quickly in damp situations, and unless given preservative treatment, hemlock ties do not last long. Manufacturers of boxes and crates use much hemlock. The wood is also employed by car builders, manufacturers of refrigerators and farm implements, but the largest demand comes from those who use the rough lumber.

"The summer wood of the annual ring is conspicuous, and the thin medullary rays are numerous."

SPRUCE, HIMALAYAN. *Picea Morinda*, Link. Weight, 31 lbs. India.

The wood of this tree greatly resembles that of the European spruce, and contains the same well-known black knots. While its commercial value is not at the present time very great, yet the Indian supplies fill an important place in the reserves for the future needs of the Empire.

The concentric layers form a grain which is comparable with that of the cedar, though this wood is probably of a milder nature.

Spruce, Japanese. *Abies Mariesii*, Mast.; and *Picea ajanensis*, Fisch. Japan.

There are two varieties of wood which have been described as Japanese spruce. According to information which has been received, all the shipments landed in England have consisted of two varieties only. These are "Todo Matsu" (*Abies Mariesii*, Mast.), and "Yezo Matsu" (*Picea ajanensis*, Fisch.). Both of these are considered to be spruce, and to correspond with the European spruce.

There has nevertheless been found mixed with these shipments a variety which bears a closer resemblance to red Baltic pine—the Scots pine (*Pinus sylvestris*), but which it is possible may be Japanese red pine (*Pinus densiflora*, S. and Z.). The confusion which has arisen was caused by the fact that the information regarding these shipments stated that they did not include any red pine.

It is estimated that there is an annual supply of 750,000 tons of this Japanese spruce; that is, 500,000 tons of "Todo Matsu" and 250,000 tons of "Yezo Matsu."

Spruce, Silver. *Picea sitchensis*, Carr. Western Canada, United States.

This timber is produced from enormous trees of great length and girth, which rank high amongst the giants of the forest, comparing even with the lofty eucalypts of Australia. Notwithstanding the fact that the timber is close-grained, remarkably free from knots and, relatively to its weight, stronger than any other timber procurable, yet before the European war it was scarcely known outside its own country. Indeed the only use to which it was put in the United Kingdom was the limited quantity purchased annually by the navy for making long oars, a purpose which required a timber of this character free from knots. During the war a dramatic change occurred, for owing to the sudden demand for great quantities for the manufacture of aircraft, the value suddenly rose to ten times, or even more, that of its pre-war price.

It was subsequently discovered that the supplies were the product of a number of different botanical species, including even Oregon pine (*Pseudotsuga Douglasii*). Enquiry ensued, which resulted in the establishment of the British Engineering Standards Association. Under this Association a committee was appointed which decided the specifications for all the timber required for aircraft material. The silver spruce used was to be of the above species, while the first qualities of any of the following woods were admitted as approved substitutes:

Quebec spruce (*Picea alba* and *P. ingra*, Link.).
White Sea white deal (*P. excelsa*, Link.).
White Sea red deal (*Pinus sylvestris*, Linn.).

West Virginia spruce (*Picea rubens*, Sarg.).
Port Orford cedar (*Chamaecyparis Lawsoniana*, Murr.).
New Zealand kauri (*Agathis* [*Dammara*] *Australis*, Salisb.).
Canadian white pine (*Pinus Strobus*, Linn.).
Oregon pine (*Pseudotsuga Douglasii*, Carr.).

Since the war, however, the Association has, by a concensus of opinion decided that in future no substitutes shall be allowed, and silver spruce (*Picea sitchensis*) only is to be employed.

Stephegyne parvifolia, Korth. Weight, 45 lbs. India, Burma, Ceylon.

Gamble reports this wood as being a light pinkish-brown, hard and even-grained, and very similar to *Adina cordifolia*. In India it is used for building and furniture, but it has not yet been seen in European commerce.

Stereospermum chelonoides, DC. Weight, 40–59 lbs. India.

This is a hard wood of a grey colour, though it has been described as an orange yellow. It is moderately durable, elastic, and easy to work, and is suitable for furniture.

" Pores moderately sized and large, joined by narrow, irregular, wavy, interrupted belts and lines of soft tissue. Pores frequently filled with a white substance of a resinous nature, which is prominent on a vertical section. Medullary rays short, wavy, moderately broad, numerous, prominent on a radial section as long, narrow, horizontal bands " (Gamble).

Stereospermum xylocarpum. Weight, 36–47 lbs. (Gamble). India.

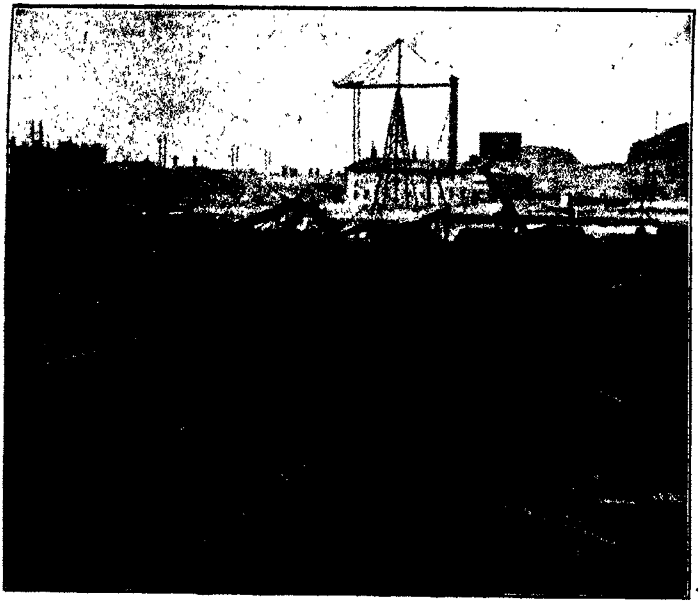
The colour of this wood is nut-brown with a glint of orange in it. The grain is close and firm. It would be suitable for decorative and cabinet work. Gamble says: " The wood is good and handsome; it is tough and elastic and takes a good polish . . . and deserves to be better known, and to be in more general use."

The pores are regular and numerous. The medullary rays are very fine, regular, parallel, and equidistant.

STRINGY-BARK. *Eucalyptus obliqua*, L'Hérit. Weight, 63 lbs. Tasmania.

This timber is of a light brown colour, much resembling English oak. It is strong, and capable of a good surface from the tool, and is used in constructional work of all kinds. It has been employed in England for a close park fence, with post and rails, and has stood the weather for twenty-one years (1919) above ground certainly as well as, and perhaps better than, English oak. Its condition is as good and sound as when first erected, and the wood is much harder. The posts in the ground, however, as well as a portion of the gravel board, have all become rotten. It does not seem, therefore, to be very durable under ground. Great difficulty was experienced in the erection, for, as it was found impossible to drive nails, the holes had first to be bored in the wood.

Stringy-bark is exceedingly difficult to season, and shrinks unevenly, the heart-wood apparently contracting more than the outer growth. For example, a plank sawn to an exact thickness of 3 x 11 inches has, when thoroughly dried, been found to be nearly ⅛ inch less on one edge than on the other.



Photograph by permission of Messrs. J. Bartram & Son, Melbourne.

PHOTOGRAPH OF THE TIMBER SHEDS, WEST INDIA DOCKS, ON SEPTEMBER 1903.

Showing the stacks of Tasmanian Hardwoods *ex* "Runic," after the disastrous fire there that destroyed eleven acres of stacked timber. These hardwoods were the only woods that resisted the fire. The view shows them lying in the ashes of other timbers.

K. C. Richardson, in his report on *Tasmanian Timbers* (p. 10) says: "After twenty-six years' experience I have found stringy-bark to be admirably adapted for piles, some of which have been in the wharves for thirty years, and are in very fair condition." Quoting Mr. J. Fincham, M.Inst.C.E., he continues, "Tasmanian blue gum and stringy-bark are the standard timbers for all Government works—blue gum is the heavier and stronger, but stringy-bark is generally preferred as being more free in working and more easily obtainable. . . . The usual life of this timber in bridges is from twenty to twenty-five years, sleepers average about fourteen years, and none of the Government railway buildings, some of which were built twenty-seven years ago (1903) chiefly of this timber, has yet been renewed. . . . It is specially suited for wood paving. It is preferable to jarrah, being quite as durable, gives a better surface, and is also lighter in weight. Given equal conditions, stringy-bark blocks will wear out two sets of the deal or beech [?] blocks which are largely used in European cities. Stringy-bark blocks do not polish under traffic, but give a good foothold for horses. Paving in this wood of the roadways of the Hobart Market building, laid in 1853, are still doing duty."

The pores are variable in size, and are arranged in groups, some are plugged with gum. The medullary rays are exceedingly fine, parallel and close together, generally equidistant; they are irregularly joined at right angles by very faint lines of a similar character.

SUGI. *Cryptomeria japonica*, Don. Weight, 30 lbs. Japan, Formosa.

This is a strong reliable timber, having the characteristic marking found in Oregon pine, pitch pine, cypress, and sequoia, of which timbers it most resembles the last named—though it is much harder and firmer in the grain, and is of a dull nut-brown colour. The dark and light streaks of brown and yellow form a wavy pattern, and the bright spots of gum sparkle and give the wood a slightly lustrous gloss. A certain quantity of this wood has been buried and, according to Goto, undergone carbonification, making the colour a still deeper brown. It possesses all the qualities requisite for making good and durable work of all sorts. It has not yet been imported into the United Kingdom on a commercial basis.

The concentric layers are strongly marked by light and dark rings, the growth being very slow and layers small. The pores are very scarce and small, and although plugged, do not show the gum on the grain end. On the tangential section they show as an abundance of exceedingly fine parallel lines. The medullary rays are very fine but clearly marked.

SUNDRI. *Heritiera minor*, Roxb. Weight, 67 lbs. (Troup). India.

This wood is brownish to dark-red in colour; very hard and close grained, elastic, strong, and durable. It is one of the timbers mentioned in Mr. Gamble's list as being likely to be available in fair quantities. In connection with its durability Mr. F. I. Dalton, extra-assistant Conservator of Forests, cites instances (in India) of rough trimmed posts placed in water-logged soil, within reach of the tide, having lasted thirteen years, and of posts placed in a somewhat more elevated, though very damp, situation, having lasted for eighteen years. The timber is extensively used in boat-building. There is a standard market for it in Calcutta, where it is in demand.

SYCAMORE. *Acer Pseudoplatanus*, Linn. Weight, 38 lbs. 9 oz. Europe.

The name sycamore is the term used in England for the wood of the maple, to which in Scotland the name plane tree is applied. The term sycamore is strangely misused in England for the produce of *Acer Pseudoplatanus*, which should correctly be described as maple, whereas the produce of *Acer campestre*, Linn., which should be called sycamore, is named maple. The reverse method, which is correct, is employed in America.

The wood, which has a close, firm, tough grain, is a pale whitish-yellow. After exposure to the air it becomes whiter, but when this exposure is continued the wood again inclines to its original yellow shade.

Although its qualities should have recommended it for more general use, yet it has of late years been chiefly in demand for veneers. Some of these have been of the wood in its natural condition, especially when the tree has displayed a figury nature. More generally, however, the wood has been stained a silver-grey colour, by the process described in the section on artificial harewood (*q.v.*). Another important use for sycamore is for the manufacture of large rollers for washing and other machines of various kinds. It has also been effectively used for flooring. The State staircase or main gangway for State occasions, for the use of the King and Queen on His late Majesty King Edward's steam yacht, was made of sycamore. It was much used in marquetry in the sixteenth and seventeenth centuries.

Although perhaps it may be said that every kind of tree has its proper time for being felled, and no other is so good, yet this is especially applicable to sycamore. The reason is that the colour is of so great importance in this wood, and it is only possible to obtain the desired result by felling immediately the sap has ceased to flow. It is also essential that the tree should be converted as soon as possible after felling.

The pores are fairly numerous, and irregularly placed. The medullary rays show as distinct white lines. The concentric circles are clearly visible with the naked eye.

TALLOW WOOD. *Eucalyptus microcorys*, F. v. M. Weight, 59 lbs. 8 oz. Australia.

The wood of this tree is hard in texture and has a rough grain running in different ways, and it therefore requires a very sharp tool to produce a smooth surface. It is a dull yellow-brown colour, with rather a golden tint, and sometimes presents a pretty figured appearance. When cut, it has a somewhat greasy, clammy feeling to the hand. It is very liable to split and crack in seasoning, developing a number of shakes or fractures across the grain, which never permanently close. In this country it is exceedingly difficult to season, and during the process it displays uneven shrinkage, inclining to twist, so that the surface will have hollow places where one part of the grain has shrunk more than another.

In Australia it is used for many purposes, including spokes, felloes, and flooring, and it is said to be durable under all conditions. It has been used largely for wood pavements in Australia, and is reported upon by the Hon. H. B. Lefroy (*Western Australian Hard-woods*), as being one of the numerous woods which are eminently suited for wood paving. It has not, however, shown satisfactory results for the same purpose in London, as the grain is too hard and irregular. Only a limited supply has been available in England, and there is not yet much prospect of further development.

The pores are numerous and irregular, and are generally plugged. The medullary rays are exceedingly fine and close, parallel and irregularly placed.

TAMARACK. *Larix americana*, Mich. Weight, 38 lbs. (Hough). North America.

This, the American larch, somewhat resembles the European wood in colour and texture, though it is perhaps tougher and harder. It is used in that country for much the same purposes as those for which European larch is valued.

Hough describes the wood as being of a light orange-brown colour, with thin lighter sap-wood, and says that it is valued for railway ties, posts, planks, and lumber for interior finishing. In addition to these uses, Gibson mentions that "boat-builders use tamarack for floors, keels, stringers, and knees. Fence posts and telegraph poles come in large numbers from tamarack forests. . . . [The wood is] also made into boxes, pails, tanks, tubs, and windmills."

TAPANG. *Koompassia excelsa* (Becc.), Taub. Weight, 76 lbs. 14 oz. Borneo.

This is a very dense, hard, heavy wood, strong but brittle. The colour ranges from bright to dark red, becoming almost black with age and exposure to light and air. It is often marked with a dark and light grain with some mottle, and shows the medullary rays on the tangential section as in beech, but finer. In Borneo, the large pieces are used in solid planks of from 2 to 2½ inches thick for tables and bedsteads, also for paddles, and pans for washing gold. Beccari, in *Wanderings in the Great Forests of Borneo* (p. 269), writes: "The most valuable things in this house were immense planks of beautiful wood used for squatting on by chiefs holding councils, and also as beds. They were of a very hard, close-grained wood of a deep red colour, taking a beautiful polish, and to my thinking, finer and superior in quality to the best mahogany. The plank on which I laid my 'tilang' or bedding was over 2 inches thick, 8 feet in length, and 6 in width." These huge planks—he also quotes Mr. St. John as speaking of two planks 10 feet 6 inches by 6 feet 6 inches, and 15 feet by 9 feet—are hewn out with axes, without the use of any saws, from the huge buttresses of these enormous trees, which, in a fluted manner, or, as Beccari describes it, in "great laminar projections," soar upwards from the butt. They are hewn out of the trunk as if it were a rock, without cutting the tree down, and apparently without doing it any injury. Dr. Hose brought back from Borneo many such tapang planks, and some which had been shaped by the natives, with the axe only, to a beautiful smooth polished surface which the European finds it hard to believe has been worked with no other tool.

This handsome wood has, till recently, been unknown commercially in England. It has been used lately for violin bows, so far with good results.

The pores are scarce, rather large, and plugged with a bright glistening gum. The medullary rays are clear and fine, but very irregular and unusually rounded. They are joined at right angles by somewhat similar light lines strongly defined, and giving, especially on the tangential surface, a marked likeness to a spider's web. There is also a beautiful ripple mark on all sections, which, coupled with the somewhat metallic lustre of the wood, gives, when finely worked, a very good appearance.

TAPINHOAN. *Silvia navalium*, Fr. Allem. Weight, 55 lbs. Brazil.

This is a light straw-coloured wood with a firm, hard, even texture and close grain. A feature of this wood is its uniform regularity of colour. It resembles the canella tapinhoan, also of Brazil, but is of a better character, and is likely to find more uses. It is reported as being used in Brazil for building canoes and boats, and largely in cooperage works for barrel staves, as well as for naval and civil construction. There are many uses to which it could be advantageously put in the United Kingdom, and particularly it might be employed in the brush trade.

The pores are numerous, but very small. The medullary rays are very obscure, and can only just be discerned with a magnifying glass (12×).

TARAIRE. *Beilschmiedia Tarairi*, Benth. and Hook. f. New Zealand.

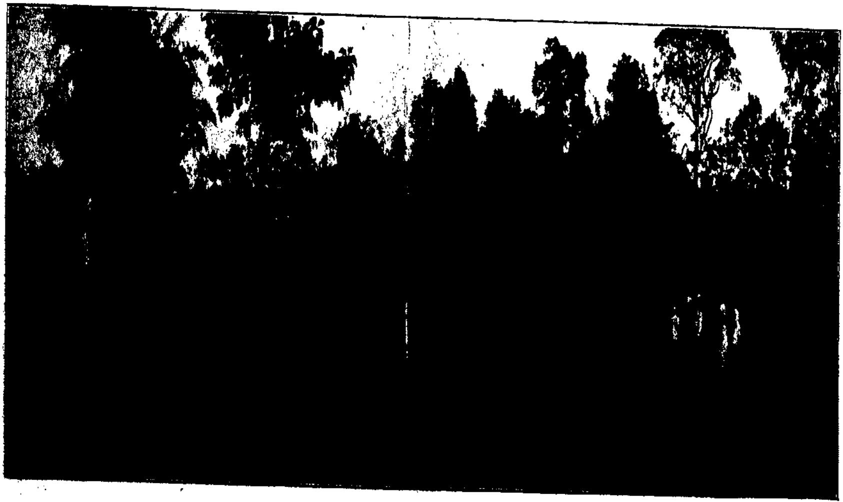
The New Zealand Board of Agriculture describes this as of a "reddish-brown colour, remarkably straight in the grain, close, but rather brittle,

Photograph by A. Rodger.

ONE OF THE OLDEST TEAK PLANTATIONS IN BURMA, MADE IN 1864.

ELEPHANTS MOVING TEAK LOGS.

Photograph by A. Boyd.



TEAK LOG BEING EXTRACTED IN A BUFFALO CART.

Photograph by A. Boyd.

Photograph by R. S. Troup.

NILAMBUR TEAK PLANTATIONS.

Tree with man at base, 7 feet 8 inches in girth.

Photograph by A. Rodger.

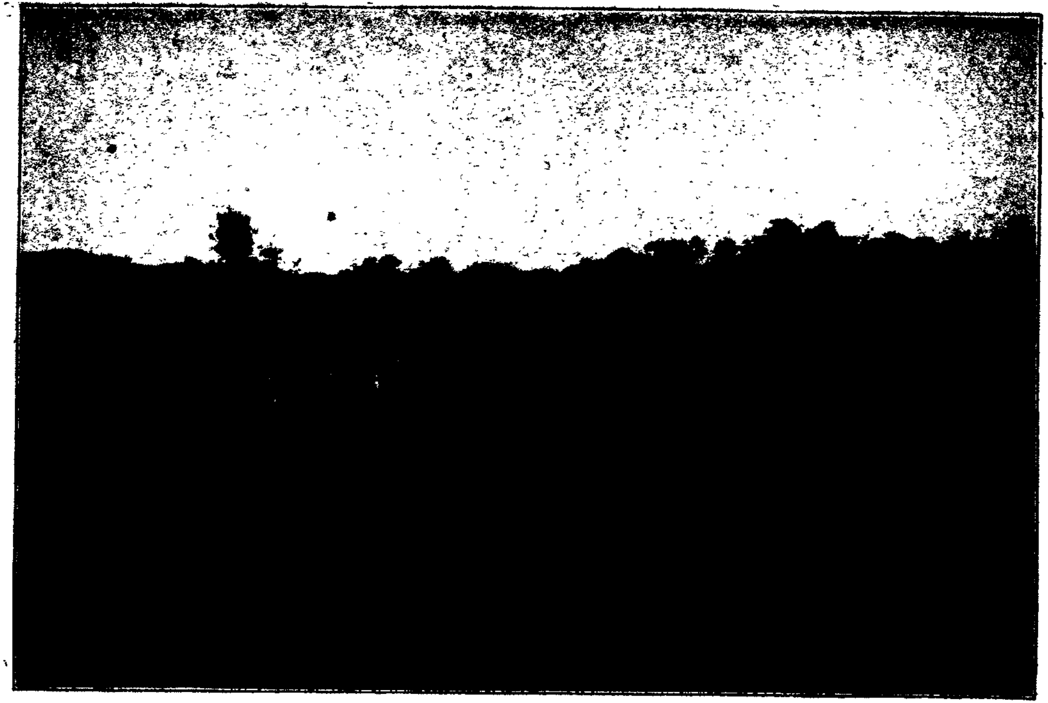
YOUNG TEAK TREES, LOWER BURMA.

Photograph by A. Boyd.

ELEPHANTS LOADING TEAK.

Photograph by A. Boyd.

TEAK TIMBER IN THE FOREST.



Photograph by A. Rodger.

YOUNG TEAK SPRINGING UP IN A BAMBOO-FLOWERED AREA.

Photograph by A. Rodger.

TYPICAL TEAK FOREST, UPPER BURMA.

Photograph by R. S. Troup.

TEAK LOGS ON DRAGGING-PATH, PREPARED WITH CROSS-BILLETS, KONTHA, PYINMANA, BURMA.

Photograph by A. Boyd.

Elephants taking Teak Logs on Tramway to the Irrawaddy River.

Teak Logs being pushed over a Bank to the Irrawaddy.—A

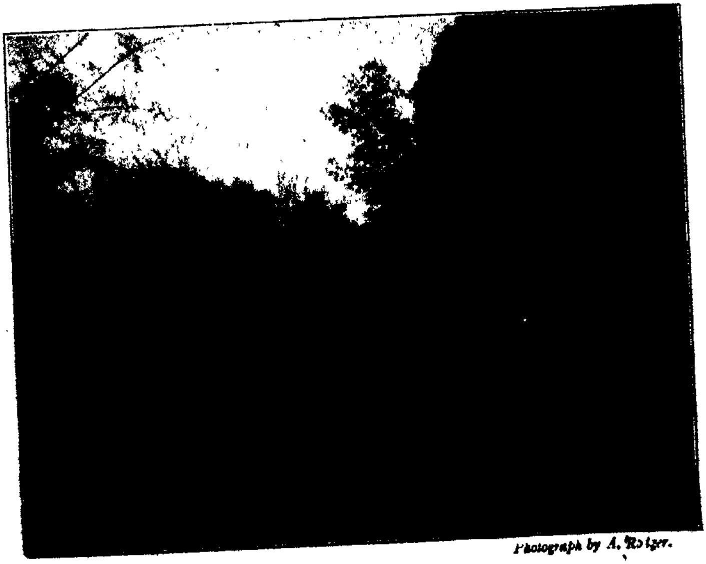
Teak Logs lying waiting for the Rise with the Rains.

Photograph by R. S. Troup.

Teak Logs placed in Upper Reaches of Floating Stream ready for Flood, Kontha, Pyinmana, Burma.

Photograph by R. S. Troup.

TEAK LOGS, UPPER BURMA.



Photograph by A. Rodger.

THE FIRE LINE IN THE THAYETMYO FORESTS.

Teak Logs being pushed over a Bank to the Irrawaddy.—B.

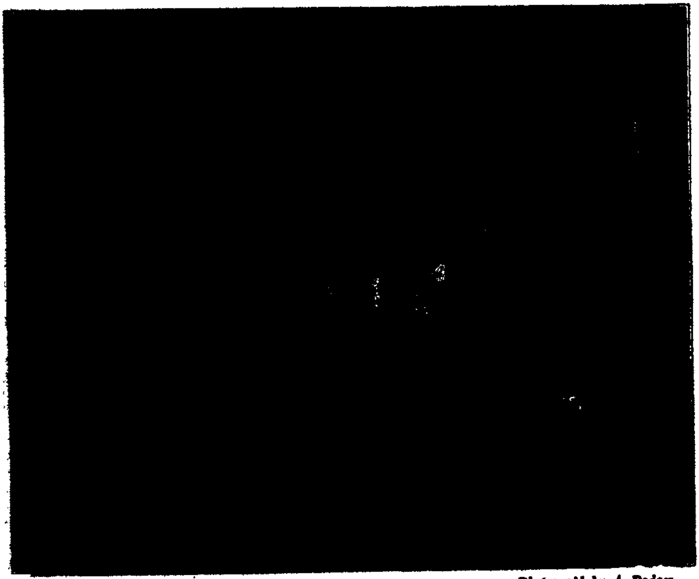
Photograph by J. Boyd

Teak Logs being pushed over a Bank to the Irrawaddy.—C.

Photograph by A. Rodger.

TEAK FLOATING IN LOWER BURMA IN THE DRY WEATHER.

(1) A dam ready to be broken.



Photograph by A. Rodger.

TEAK FLOATING IN LOWER BURMA IN THE DRY WEATHER.

(2) The dam after the first rush of water has subsided.

Procurable in long lengths, and up to 12 inches in width. Used for ships' blocks and for cheap furniture."

TAWHAI. *Fagus fusca*, Hook. f. Weight, 53 lbs. New Zealand.

This timber, which is also known as black birch, is, according to the Board of Agriculture, New Zealand, "red in colour, straight, even, compact in grain, tough and durable in all situations. Procurable in long lengths, and up to 24 inches in width. Used for piles, stringers, bridge and wharf planking, and mining-timbers."

Baterden says that this wood "was the only timber used for a stiffened suspension bridge, spanning Chasm Creek Gorge."

TEAK. *Tectona grandis*, Linn. Weight, 45 lbs. India, Burma, Siam, Java.

The supplies of this timber are shipped from Moulmein and Rangoon in Burma, Malabar in India, Bangkok in Siam, and from the Island of Java. Mr. McKinlay says that he found one patch of true teak (*Tectona grandis*) in the Philippine Islands, where the trees appeared to be about forty years old and were growing in close forest as though they had been planted.

The wood varies from yellow or straw colour to a rich brown when first cut, darkening on exposure; sometimes it has dark and almost black streaks or veins, this last feature being more often found in the Java wood, and in that from some parts of the Indian Peninsula. Troup speaks of the so-called "Godaveri teak" as being particularly handsome in this respect.

Teak works with an oily surface, and when first cut has a sticky feeling to the hand. It is moderately hard and strong, clean, even and straight in the grain, and is easily worked. It shrinks very little in seasoning, and the logs do not side-shake. It contains an essential oil which clogs the pores and resists the action of water; this often oozes into and congeals in the shakes which radiate from the pith, forming there a hard concrete substance which blunts the tool. The oil also acts as a preventive of rust when iron is in contact with it, and for this reason teak is preferred to all other known woods for the backing to the armour-plates of ironclad ships of war. The wood often contains a white deposit. This was analysed in an experiment made in 1862 by Professor Abel, which is quoted by Gamble, with the following result:

	Per cent.
Lime	34·04
Magnesia	1·86
Ammonia	1·12
Phosphoric acid	43·35
Water and organic matter	19·54
Carbonic acid	0·09

The trees in the forests are girdled; that is, they are ringed completely round to the heart-wood three years before they are intended to be cut down. The trees then soon die, when they become light enough to be floated down the rivers. If felled without this precaution the timber will sink. Thirty years ago the supplies reached England about a year from the time of felling, but now more often a period of 3 to 7 years elapses. At that time many of the forests worked were comparatively close to the seaport, but now the trees often have to float down the rivers a distance of from 1000 to 1500 miles.

Mr. Andrews says that throughout the whole of Burma at that time it was possible to cut 75 per cent of prime clean timber, free from fault, from the trees, while now they have difficulty in getting more than 10 per cent. The hauling is done by elephants, and the increased cost and difficulties of the log-extraction can be understood when we know that formerly the cost of an elephant was about £100, while in 1914 it was from £300 to £450; and while an elephant was then able to haul 120 trees in a year, now, on account of the greater obstacles, it can only deal with from 30 to 40. The immensity of the necessary organisation can be illustrated by the fact that in 1913–1914 the Bombay Burma Trading Company employed 2500 elephants and 6000 buffaloes, to carry on the work of transport. The round trunks, arriving at the port of shipment, are sawn into square logs, planks, boards, and scantlings, and also into blocks for railway-carriage wheels and keys for railway-chairs.

Mature teak trees are often found to be hollow in the middle, and it has been thought possible that fire may be a partial cause of this. Drastic measures were adopted by the Government about forty years ago, to check the ravages of these fires, and fire-zones were cut, which in certain districts had the desired effect. Troup, however, remarks "that in these districts the regeneration of the forest has been entirely stopped, while where the fires have continued there is a sufficient growth of healthy young trees." He thinks that this remarkable result is due to the unchecked vigorous growth of other vegetation choking the young shoots of teak, whereas, when the fire burns down the undergrowth, these survive. The first year the shoot springs up and is burnt down when the fire comes; the next year another shoot comes up and is again burnt; but after three or four years the root is found to be more vigorous and strong, and finally puts up a fresh tree which establishes itself. Those that are hollow are converted into large-sized flitches, which are very valuable on account of their size and freedom from heart or fault.

The teak tree is remarkable for its large leaves, which are from 10 to 20 inches in length and from 8 to 15 inches in breadth, of an oblong shape, and so rough that the natives use them for sand-papering. The trees frequently attain the height of 80 to 100 feet and more, with a circumference of from 6 to 10 feet and over. The largest log recorded was one from the Ruby Mines Division, Upper Burma, launched in 1898, which measured 82½ feet in length, 12 feet in girth at the base, and 7 feet in girth at the top, and contained 507 cubic feet of timber which would weigh over 12 tons. Even after this length was cut there was still a considerable sized log to be cut from the top.

A great many of the trees are inclined to be very crooked, and the stems are often twisted and fluted, making the conversion difficult and costly. To-day the best quality is considered to be that from Moulmein, although it is difficult to recognise any material difference between that and other varieties. Perhaps the Rangoon timber is slightly more crooked in the heart, while that from Bangkok, though better in this respect, is found to contain more bee-holes. The timber from Malabar is slightly denser, harder, and heavier. Teak from Burma and Siam may often be found quite seasoned on arrival, but there is sometimes a little shrinkage: twelve pieces—each 30 inches by 2 inches square, after being subjected to a dry heat of 120° in a seasoning chamber, showed no shrinkage in length; six pieces were found to have shrunk $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in width. To most people the scent of teak being sawn or worked is agreeable, as also is the scent of a room panelled or trimmed in it, but others regard it as being unpleasant, and occasionally some parcels have had an exceedingly foul smell. In one case expensive fittings costing many hundreds of pounds, finished and fixed, were entirely rejected on this account, and had to be replaced by other wood, though no similar case has been reported.

Besides the immense quantities required for the navies and shipbuilding of the world, a vast amount is used for railway-carriage construction, and for this work, notwithstanding the great cost, it seems almost impossible to find a satisfactory substitute. Where it is used for panels for railway carriages it might perhaps more often be desirable to substitute mahogany, which is already largely employed. The quantity of teak used, both on account of its fire-resisting qualities and its immunity from the attack of the white ant, is enormous. It is also used for accumulator boxes, as the nature of the wood resists the action of the acids used, and it does not warp or split. It is largely used for floorings for public buildings of all kinds. For such work, however, the fibrous nature of the grain renders it liable to be cut by the tread of nailed shoes, which soon break down the wearing surface. For hard wear of this character other timbers can be substituted with better results at less cost, but it is very suitable for hospitals, where its oily nature and reliable standing qualities provide a sanitary floor with a good effect. The wear which the floors of a hospital sustain is light, so that a harder wearing surface is not necessary. Of late years the greatly enhanced cost has tended somewhat to reduce its use for window-sills and frames, and other forms of joinery work, for all of which purposes there are, fortunately, at present abundant supplies of equally satisfactory timbers which can be obtained at less cost. In India it was formerly largely used for sleepers, and all kinds of building construction, but here also the increased cost has made it necessary to adopt substitutes. Where used in India for sleepers, and in England for posts buried in the ground, it has been found to be very durable, more so indeed than oak. In strength, resistance to crushing, and transverse strain it ranks high, although not so high as many other Indian timbers. R. S. Pearson, F.L.S., has made very exhaustive tests which give the relative strengths of the product of teak grown in plantation and natural forest respectively, and which can be seen in an admirable pamphlet (*Forest Bulletin*, No. 14, 1913), entitled "A Further Note in the Relative Strength of Natural and Plantation-grown Teak in Burma." "As a rule, teak in Burma is felled when it reaches a girth of 7 feet at breast height. It then varies in age from 110 to 190 years in natural forest, the average being 150" (R. S. Troup, private notes).

Large areas of artificial plantations have been formed. These were commenced in 1862, and have been continued ever since, their total area at present amounts to nearly 70,000 acres. It will probably be about thirty to forty years before they commence yielding regular supplies of large size, but the out-turn then will be by no means negligible. The famous teak plantations of Nilambur in Malabar deserve special mention. These plantations were commenced in 1842, since which date continual additions have been made. They now aggregate about 5,000 acres, though probably only one-third of this area will produce timber of large size. Already, however, a good many trees have reached a girth of over 7 feet.

The out-turn of teak from Burma in the 5 years preceding the war was:

1908–1909 . . .	270,140 tons.
1909–1910 . . .	284,607 „
1910–1911 . . .	309,787 „
1911–1912 . . .	252,723 „
1912–1913 . . .	255,876 „

• It is worthy of note that before the European war the Germans were purchasing regularly one ton of teak seed for planting in the colonies which they then possessed in East Africa. The enterprise thus shown with regard to this valuable timber might well be more largely followed by the British Government.

Rows of regularly arranged pores mark the annual rings; the other pores, which are variable in size, are scattered and few in number.

The medullary rays are fairly numerous, and give a fine silver-grain effect.

TEAK, JAVA. *Tectona grandis*, Linn. f. Weight, 45 lbs. 7 oz. Java.

The supplies of teak from Java come from the seven districts of Remband, Semarang, Madioen, Sourabaya, Cheribon, Kembal, and Kedire.

From the district of Remband " Blora " teak is obtained, which is the best quality obtainable in Java. The next best comes from Semarang, but some from this district is not good. Madioen has some good teak, but most of the timber is chalky. Sourabaya wood is not very good, being light in colour and weight. The supplies from the remaining three—Cheribon, Kembal, and Kedire—are all of inferior quality and full of chalk.

The teak tree is not indigenous to Java, but the conditions are remarkably favourable to its growth. Originally planted round the temples or shrines, it has spread over a wide area in pure forest, unlike its habit in Burma and India, which is that it invariably grows in mixed forest. In many places a very free natural regeneration occurs, so that often in a few weeks a magnificent healthy new crop of young seedlings will spring up and flourish vigorously. On the other hand, the conditions are not favourable to satisfactory growth in the later life of the tree, which becomes stunted and will not produce the same straight boles as can be found in Burma and Siam. Thus the produce of the trees is of less size, and it is difficult to obtain any quantity of long timber. The densely populated island of Java uses a very considerable quantity of teak annually, as there are no other domestic jungle woods, such as are largely used in India for all purposes, and many of which have now to be imported into Java to keep up the required timber supply. There is not, therefore, much prospect of any considerable export of teak in the future. The effect of a change that the Government has lately made in the manner of selling the timber has also restricted the volume of export. Until recently, in spite of large supplies of good quality from Java, obtainable at a lower price than the Burma wood, it was found difficult to overcome the prejudice against it. This was due partly to the manner of description: the term Java being used to describe the whole of the supplies without discrimination, whereas the quality of Blora teak was good enough for the best purposes, and some of the other hardly fit for common use. This difference was well understood by the Dutch at home in Holland and by the shippers in Java, and better qualities commanded a proportionately higher price. The very heavy rise in the value of the Burma and Siam wood which has taken place during the last few years, has had the result of stimulating the inquiry for Java teak, and many who would not formerly entertain it are now anxious to obtain supplies.

The colour varies from a light straw colour, paler than that of the wood from Burma, to rich brown, equal to any other sort. Some of it is harder to work, heavier in weight and chalky, and the gritty nature of the wood blunts the edges of the tools readily, but the best quality obtainable is as good as any of the Burma or Siam timber, from which it is impossible to distinguish it. It generally contains a more curly and wavy grain, and a much larger proportion of what is termed "roe and mottle" figure. A special feature of Java wood is the dark coloured, almost black, streaky marks which it contains, and which make it very attractive when used for panelling or any decorative work. This last quality is so pronounced that, for those who desire to secure the best appearance in teak panelling or furniture, it would be worth while to specify the use of Java.

TEAK, SURINAM. Source unknown. Weight, 70 lbs. 8 oz. (very wet and fresh). Surinam (Dutch Guiana).

Eight square hewn logs of a timber described as Surinam teak formed part of a cargo which was imported into London during the European war, though intended for Havre. No certain identification is possible, but it is probable that this is the timber described by Stone and Freeman in *The Timbers of British Guiana* (p. 82), and called "Locust," the product of *Hymenoea* sp. The wood bears no resemblance to true teak (*Tectona grandis*) in any respect.

The colour is a light brick-red, with slightly lighter streaks, or it might be described as "a dark brown to orange-red wood, often streaky," which are the terms used by Stone and Freeman. It is of a hard texture with rather an open grain, and has proved to be a reliable wood, standing well when seasoned, and having all the qualities which would make it durable. It would make a very pretty decorative or cabinet wood, and would also be particularly good for turnery.

Of its qualities Stone and Freeman say, "A wood of good appearance, which may be of use as a substitute for inferior mahogany. It should be worth a trial for paving-blocks. Hard to saw, takes nails badly. Fissile, splits easily; planes and turns moderately hard, but well."

I consider it equal to the best mahoganies, and for many reasons quite unsuitable for paving-blocks. It is essentially a cabinet-maker's and turner's wood.

The pores are regular and usually even in size; they are generally single, but sometimes occur in duplicate and triplicate. The medullary rays are strongly defined, and at uneven intervals are joined at right angles by a clear light ring, similar in appearance, which follows the line of the concentric layers and marks their line of growth.

Terminalia Arjuna, Bedd. Weight, 59 lbs. India.

The wood is a bright, light yellow straw colour, with a close, rather rough grain. Gamble speaks of it as being not easy to work, and apt to split in seasoning. It might make good golf club heads.

The concentric layers are marked by regular, light bands. The pores are small and uniform. The medullary rays are very fine, numerous, and parallel, and nearly equidistant.

Terminalia bialata, Wall. Weight, 48 lbs. Burma, the Andaman Islands.

The produce of this tree appears to be divided into two distinct kinds. The first consists of wood which is wholly of a bright chrome yellow. The second has only a narrow ring of this yellow wood, the remainder being of a light nut-brown colour with dark streaks, somewhat resembling Italian walnut, and possessing a fine, smooth grain. The larger proportion of the shipments is of this second variety. It is a very attractive and agreeable furniture and decorative wood, which would undoubtedly be highly valued for cabinet work if supplies were obtainable in a regular manner. Gamble reports thus on it: "In the list of Andaman woods, Calcutta Exhibition, 1883–84, this tree is said to be abundant, having a wood the colour of old oak, which works and polishes beautifully . . . and squares up to 60 feet long, siding 30 inches . . . the wood makes good furniture, and is used for oars, buggy shafts, and floor and ceiling planking." Whilst being unable to agree with Mr. Gamble in his opinion about the colour—the above description being more accurate of our specimen—and far more attractive therefore on account of its unusual character—in other respects the report is very satisfactory, and especially as regards its size and abundance. It should be exported freely, and a good result could be confidently expected.

Reports have just reached me that the wood has been largely used, with most satisfactory results, for making aeroplane propellers. For this work, however, the bright yellow variety has been chosen as being preferable. As a wood suitable for this purpose must of necessity possess the highest possible standing qualities, this report places *T. bialata* on a very high plane. After being thoroughly seasoned it would be suitable for any work which requires wood which shall stand well without warping or twisting.

"The pores are very scanty, large, frequently subdivided, joined by irregular, wavy, concentric bands of soft, loose, cellular tissue. Fine equidistant, uniform medullary rays are distinctly visible in the harder and darker portions between the bands, and on the radial section where too the pores are prominent" (Gamble).

Terminalia Catappa, Linn. *The Indian Almond.* *Weight, 32 lbs. (Gamble); 37 lbs. (Troup).* *India, Burma, the Andaman Islands.*

The wood is a rather bright brick-red colour, with specks of shining gum in the pores, and a fairly smooth and even grain. It possesses a hard surface for such a light wood, but is evidently liable to warp and twist badly, even in small sizes, and on this account it could not be recommended for use for any purposes in the United Kingdom to an extent which would justify its export.

The concentric layers are marked by a conspicuous dark band. The pores are so uniform and regular that they give the impression of a hand-manufactured pattern. The medullary rays are very close, parallel, and exceedingly fine.

Terminalia Chebula, Retz. The Myrobolan tree. Weight, 64 lbs. Burma.

This moderate-sized tree yields squares up to 30 feet × 12 inches × 12 inches. The wood is brownish in colour and is hard, tough, and fairly durable. It polishes well, though it does not work very easily. It is used in Burma for house-building, furniture, carts and oars, and is obtainable in fairly large quantities.

Terminalia Manii, King. Weight, 39 lbs. Andaman and Nicobar Islands.

The native name of this wood is black chuglam. It is of a greyish-brown colour, somewhat resembling walnut, and takes a smooth and lustrous surface from the plane. In a private note Mr. G. R. Keen speaks of it as showing great promise of being an excellent substitute for ash for aircraft. He adds that it is superior to *T. bialata* for this purpose.

Terminalia procera, Roxb. Weight, 40 lbs. India, Burma, Andaman Islands.

Gamble gives this as a synonym for *T. Catappa*, but according to my specimens the woods are not identical. *T. Catappa* is a bright brick-red, but *T. procera* is a light yellowish-brown to grey, not unlike walnut. It is moderately hard and close-grained. It would be useful for ply-wood.

Thespesia populnea, Corr. Weight, 50 lbs. India.

This, the wood of the Portia tree or tulip tree, is of a pale salmon-mahogany colour, with a close texture and a grain having contrary hard and soft layers, and showing the medullary rays as silver grain on the radial section. Gamble reports it as " durable . . . used in South

Photograph by G. R. Keen.

CONVICTS FELLING A *TERMINALIA PROCERA* TREE IN THE ANDAMAN ISLANDS.

India for gunstocks, boats, cart and carriage making, and for furniture; in Bombay for wheel-spokes; in Burma for furniture and carts."

The pores are small and regular. The medullary rays are clear, strong, and well defined.

THINGAN. *Hopea odorata*, Roxb. Weight, 39–58 lbs. (Gamble). Burma, the Andaman Islands.

Small shipments of this timber have arrived in this country, but not in sufficient quantities to make it known or in demand. It is of a light, rather bright, yellowish-brown colour, is straight-grained, and would be useful for many cabinet and decorative purposes. Foxworthy says that this timber is probably the commercial equivalent of yacal from the Philippines; but the Indian variety is milder, lighter in weight, softer in texture, and less interwoven in the grain. Gamble reports it as very durable and capable of resisting white ants. " Boats made of it are said to last twenty years." It is also used for house-building, canoes, solid cart wheels, and in the Andamans it gives squares up to 40 feet long with 2 feet siding; is reputed good for ships' blocks, bits, and capstan bars, carriage- and boat-building. If exported and properly known, there is little doubt but that it would be much sought after.

The pores are confused and irregular and are plugged; the medullary rays are fine, parallel, and not very prominent. Gamble speaks of a beautiful silver grain on the radial section, but it is not apparent on my specimen.

THITKA. *Pentace burmanica*, Kurz. Weight, 42 lbs. (Gamble). India.

This timber has been recently imported into Liverpool, probably for the first time commercially, in long logs with about 11 inches to 16 inches siding, rough sawn, nearly square. It is of a light brick-red colour, with lighter and darker shade or roe; it is bright and has a certain glossy sheen, while little specks of gum shine brightly on the tangential surface. It is of a hard, close texture, and is capable of a smooth surface. According to Gamble " it has been largely exported," but as stated above it has not been seen till recently in the United Kingdom. It does not appear to shake to any extent, but it is rather liable to warp. It would provide a bright, showy wood for shop-fittings or cases.

The concentric layers are well defined and the pores evenly scattered, numerous, and fairly open. The medullary rays are parallel, equidistant, and inclined to wave.

TIMIDAK. Source unknown. Weight, 46 lbs. 4 oz. Borneo, the Malay States.

This is a cross-grained, fine-textured wood of a light yellowish-brown colour, with a surface very similar to that of Honduras mahogany. It takes a nice finish from the tool, stands well, and would be a useful substitute for any work for which mahogany is used.

The pores are of moderate size and rather open. The medullary rays are close, fine, and parallel.

TITOKI. *Alectryon excelsum*, Gaert. New Zealand.

The Board of Agriculture, New Zealand, reports this wood as of a "light-red colour, straight-grained, of great strength, toughness, and elasticity. Used in wheelwrights' and coachwrights' work, axe handles, swingle-trees, and handles of carpenters' tools."

TOTARA. *Podocarpus Totara*, A. Cunn. Weight, 28–37 lbs. New Zealand.

This is one of the most valuable timbers of New Zealand. It has not been imported on a commercial scale. The Board of Agriculture, New Zealand, reports it as "deep red in colour, clean and straight in the grain, also capable of resisting the marine worm for protracted periods. Procurable in long lengths and up to great widths. Used for general building purposes, joinery, and cabinet-making; bridge and wharf work, and wood pavements." Some years ago many well-marked pieces were sent to this country for figured veneer work, the figure being of a curly, wavy, burry character. The veneers were well received and were used for panels in pianoforte work and cabinets.

TOWHAI. *Weinmannia racemosa*, Linn. Weight, 45 lbs. New Zealand.

According to the New Zealand Board of Agriculture, this wood is of a "deep red colour, hard and strong, ornamental grain. Procurable in medium lengths up to 10 inches in width. Used for cabinet-making and ornamental work."

TRINCOMALI WOOD. *Berrya Ammonilla*, Roxb. Weight, 60 lbs. (Troup). India, Ceylon, Burma, the Malay States.

The colour of this wood, which is alternatively known as petwun, is a deep dull-red, very similar to that of beef-wood or bullet-tree; it has a very close, firm, hard grain, and a sticky or oily feeling to the touch. In this respect, as in its colour, it resembles the heart-wood of lignum vitae. According to Troup it is difficult to saw and seasons well, although he recommends seasoning in the log "to prevent the formation of small radial cracks which are apt to form if the wood is converted green. . . . Owing to its toughness, elasticity, and straight grain . . . recommended for carriage shafts and other purposes requiring these properties." Gamble says "the wood is very durable. It is used for carts, agricultural implements and spear handles, and is much esteemed for toughness and flexibility." Experiments made by Professor W. C. Unwin, F.R.S., in 1899, gave the following results:

Weight	49·93 per cub. foot.
Resistance to shearing along the fibres	830·3 per sq. inch.
Crushing stress	3·442 tons per sq. inch.
Coefficient of transverse strength	6·898 ,, ,, ,,
Coefficient of elasticity	780·7 ,, ,, ,,

It appears to me that its characteristics point to its suitability as a substitute for lignum vitae for some of the purposes for which that wood is so much in demand.

Photograph by G. R. Keen.

NATIVES HAND-SAWING, CEYLON.

The pores are very small and are generally regular; they are joined by wavy belts of minute secondary pores, which make a pretty pattern.

The rays are exceedingly fine; they are parallel and equidistant. The pretty ripple ray pattern is noticeable on both sections.

TSUGA. *Tsuga Sieboldi*, Carr. Weight, 38 lbs. Formosa.

This is a fine-grained, heavy, hard-textured wood similar in appearance to Scots pine (*Pinus sylvestris*) but much harder and heavier. It has not hitherto been imported into the United Kingdom, but it would prove a very valuable timber for a great number of purposes if regular supplies could be maintained.

TUART. *Eucalyptus gomphocephala*, DC. Weight, 70 lbs. (Julius). Western Australia.

The wood is of a yellowish or straw colour, hard, heavy, tough, strong and rigid; the texture close and the grain so twisted and curled as to render it difficult either to cleave or work. It is a very sound wood, possessing few or no defects, with the exception of a mild form of heart- or star-shake at the centre, which would necessitate a small amount of waste if it were required to reduce the logs into thin planks or boards; but if employed in large scantlings it will be found a most valuable wood, especially where great strength is needed. It shrinks very little in seasoning, and does not split while undergoing that process; it is also characteristic of this wood that it will bear exposure to all the vicissitudes of weather for a long time without being in any but the least degree affected by it. It has been known to be subjected to this severe test for fully ten years, and when afterwards converted, it opened out with all the freshness of newly-felled timber. Possibly no better evidence is required to show that this is a durable wood. It is used in shipbuilding for beams, keelsons, stern-posts, engine-bearers, and for other works below the line of flotation for which great strength is required, a weighty material in that position not being objectionable in the construction of a ship. It would make good piles for piers and supports in bridges, and be useful in the framing of dock-gates, as it withstands the action of water and is one of the strongest woods known, whether it be tried transversely or otherwise. It would, however, probably be found too heavy for use in the domestic arts.

Julius says: "In consequence of the comparatively small quantities of this timber so far used, definite information in regard to durability is hardly available. . . . Tuart is very rarely attacked by white ant, and is not liable to attack by dry rot . . . stands well when steamed and bent as roof-sticks, and many hundreds are in use in the State for this purpose."

C. E. Lane-Poole says: "Its main use, along with wandoo, is for railway waggon and truck construction. The chief mechanical engineer in Western Australia, Mr. E. S. Hume, has reduced the maintenance of his trucks from £3 7s. 6d. to 10s. per year per truck by substituting for steel, tuart and wandoo in under-carriages."

TULIP-WOOD. *Physocalymma scaberrimum*, Pohl. Weight, 64 lbs. 2 oz. Brazil.

This wood is imported in small, round, irregularly-shaped logs and billets, ranging from 2 to perhaps 8 inches in diameter, and generally of a very faulty character. The colour is a fresh red streaked with deeper red and light yellow stripes; the growth is dense and hard. The wood is liable to split after being sawn. It is a very favourite wood in the composition of French pieces of furniture, especially of the Empire period, and it is still used to a certain extent for bandings and ornamental inlay work. It is also used in turnery. "The wood, which is very wasteful and splintery, is used for Tunbridge ware manufactures and brushes" (Holtzapffel). When exposed to strong light, the bright colour fades almost completely away, but otherwise it remains rich and effective. Supplies grow more scarce every year.

The annual layers are clearly marked. There is a scarcity of open pores; they consist of a ring of larger pores following the line of the annual layer, with numberless minute pores in between largely filled with a gummy substance. The medullary rays are irregular, exceedingly fine, and parallel.

TUPELO. *Nyssa sylvatica*, Marsh, or *N. uniflora*, Wang. Weight, 45 lbs. 7 oz. North America.

Tupelo gum, or Bay poplar, is, when thoroughly seasoned, a very valuable wood if used with judgment. It must not be employed for unfixed work such as tops, and the framework of doors and screens, as it is liable to warp and twist. For panelling and fixed work, however, it is very reliable, and when seasoned does not shrink or cause trouble. It takes a particularly smooth surface from the tool, and shows very sharp, good lines in such work as mouldings. The colour is a pale whitish-yellow, while occasionally dark patches occur. It has been largely used for electric light casings, mouldings, and general joinery work, and can be obtained in long lengths and wide widths free from defect.

The pores are very small, indistinct, and ill-defined, as also are the medullary rays. On the tangential surface the grain is very close and smooth, and the pores are very minute and shine with tiny specks of sparkling gum.

TURPENTINE. *Syncarpia leptopetala*, F. v. M. Weight, 60 lbs. 10 oz. Australia.

This wood has a very dense, hard, compact texture. It is of a light-red, plum colour, with lighter and darker marking, very similar to English cherry. It is exceedingly difficult to season, and dries with an irregular surface. It is very rarely seen in England, and is therefore little used.

Turpentine shows on the face a very finely marked medullary ray, as in beech, but much smaller and finer. The section end shows numerous pores evenly distributed, and almost entirely filled with a whitish gum; the medullary rays are hardly visible.

VERA-WOOD. South America (Maracaibo).

This timber was first imported about fifteen to twenty years ago (1919). It has been tried as a substitute for lignum vitae, and while it was found serviceable for some of the purposes for which that wood is used, it cannot be said to be so in all cases.

VINHATICO. *Echirospermum Balthazarii*, Fr. Allem. Weight, 42-52 lbs. Brazil.

This wood, which Baterden describes as yellow or reddish-yellow, with a light open grain, is, according to *Brazilian Woods*, "excellent for joinery and also sought after for cabinet-making. The trunk . . . attains an enormous thickness, 2 to 3 metres in diameter."

Vitex glabrata, Br. Weight, 40 lbs. India, Burma.

This hard, greyish-coloured wood has a beautiful satiny lustre. It is fairly durable, and is used in Burma for cart shafts, axles, wheels and oars, but is quite suitable for furniture, for which purpose, if it were better known, it would be much in demand. It yields squares 30 feet × 12 inches × 12 inches.

Vitex Leucoxylon, Linn. f. Weight, 40 lbs. (Troup). India.

This is a very nice wood, of a greyish-brown colour, and a regular, even, and close grain. Its colour and qualities would make it much appreciated for highly artistic and decorative furniture and trimming if supplies were assured and the wood became known.

The pores are small and regular. The medullary rays are broad and conspicuous, showing in very small flecks of silver grain.

Vitex pubescens, Vahl. Weight, 54 lbs. India, Burma, the Andaman Islands.

This hard-textured wood is of a warm olive-brown colour; it has a close, compact grain, and is capable of a very smooth surface. The colour and its standing qualities would fit it very well for special uses, and it should be a good wood for turning. Troup reports its use for axe handles, but it should be used as a decorative cabinet and furniture wood.

The pores are rather scarce and very small, and so formed as to mark concentric lines at irregular intervals. The medullary rays are very fine, clear, distinct, and parallel, equidistant and numerous. There is a fine mottle running through the grain.

WALLABA. *Eperua falcata*, Aubl. Weight, 62 lbs. (Stone and Freeman). British Guiana.

Stone and Freeman describe this as "a purplish-red wood, which bleeds crimson gum exceedingly freely; surface very sticky, readily collecting the dust and becoming unpleasant to see or touch; very hard. Splits very easily, straight, and fairly cleanly; takes nails badly; rather easy to saw; planes moderately hard and well. Very troublesome to polish, as it smears. It should prove a valuable wood for export on account of its hardness and resistance to decay."

Baterden mentions that it has been used largely of late years for telegraph and electrical poles in Barbadoes and Trinidad.

WALNUT. *Juglans regia*, Linn. Weight, European, 40–48 lbs.; N.W. Himalayas, 41 lbs.; Sikkim, 33 lbs. (average) (Gamble). Great Britain, France, Italy, Turkey, Caucasia, India, China.

Supplies of this familiar wood reach England from all the above-named countries with the exception of China, while from India there has as yet been scarcely any commercial export. It has been imported in the form of logs, round and square, burrs, planks, boards, and veneers. In colour it varies from light greyish-brown to dark brown, often traversed by black and golden or golden-red streaks and stripes, or it is handsomely mottled and shows a wavy roey grain.

Although walnut requires some time to season, and shrinks considerably during the process, yet when subsequently exposed to drying or moistening influences it stands excellently, and it is exceedingly difficult, if not impossible, to find another wood possessing this attribute to the same degree. For this reason it is the best wood known for gun and rifle stocks. After the rifle stock has been cut out and shaped, the wood retains its form and shape exactly, so that the rifle barrel and locks will drop into their position and rest, without bending the locks or throwing the barrel out of the straight. No variation in climate affects this. Exhaustive experiments made by Mr. Phillips, the Superintendent of the Small Arms Factory at Enfield, have shown the great difficulty of procuring any other kind of timber capable of enduring the same test.

The combination of characters which confer on walnut its reputation of being by far the best wood for gun stocks may here be summarised.

1. Relative strength, toughness, and elasticity, which provide the power of resisting shock.
2. Appropriate weight, which gives proper balance.
3. Relative freedom of the seasoned polished wood from any shrinkage, swelling, or splitting when exposed to wet, damp, or heat.
4. Uniform texture and appropriate hardness, so that the wood is readily cut into delicate shapes, yielding a smooth surface which is easily plugged by polish.
5. The hardness necessary to prevent the wood from being dented.
6. Lack of brittleness, or tendency to split, which decreases the danger of fragments of the wood being knocked off.

Recently also, walnut has been found to be very suitable for the propeller blades of aeroplanes, as, apart from its resistance to damp and drought, it shows a certain degree of toughness, or the lack of that brittleness to which I have previously referred, which excludes many timbers from such a use.

From a very early date walnut has been used for furniture and decorative work throughout Europe. The much-admired Queen Anne furniture is particularly associated with this wood, which at that period was almost exclusively used in the manufacture of the best work. Much of the rare and valuable Italian furniture and decorative architectural work of still earlier date was made in this wood.. The superb choir-stalls in the Frari Church at Venice were executed in Italian walnut in 1468 by Marco di Vicenza, who also worked in 1465 on the choir-stalls of the church of S. Stefano. The S. Zaccaria choir-stalls (Coro delle Monache) were also made in Italian walnut by Francesco and Marco di Vicenza between 1455 and 1464.[1]

The colour, general appearance, and carving qualities of the wood appeal particularly to the decorative artist, yet it seems undesirable that works of art, whose great beauty makes them worthy of permanence, should be executed in walnut, for this wood is almost invariably attacked by " worm " (boring beetles), which ultimately destroy the whole fabric. Reference has already been made in the section on oak (*q.v.*) to the crumbling walnut woodwork in Italian churches, in contrast with the intact condition of equally old woodwork of oak. The beautiful inlaid stalls and panelling and magnificent carved solid work in many of the churches in Venice are perforated with holes, and are falling to pieces, reduced to dust. The attack is by no means limited to old walnut, for fresh panelling and new furniture may become seriously "worm"-eaten within two or three years of completion. Moreover, the beetles ("worm"), thus finding in walnut a favourite feeding and breeding place, readily advance on to the similar destruction of articles made of other kinds of wood. Many authorities refer to the liability of "worm" attack on walnut as being confined to the sap-wood, but although this is the more liable, and the attack may begin there, it always spreads over both heart- and sap-wood. Besides the architectural work, much of the exquisite furniture of early date is undoubtedly lost to the present age on this account. On the other hand, there are many fine specimens extant which are still in good condition. At the South Kensington Museum may be seen a pair of folding doors in walnut inlaid with holly and pear-wood from the Palace of Federino, Duke of Urbino, at Gubbio, which date from the early sixteenth century. Of the same period is a coffer of walnut bearing the arms of the Rospigliosi and the Altieri families in Rome. Neither of these show signs of decay.

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[1] According to a private letter of Mr. Gerald Campbell, H.B.M. Vice-Consul at Venice (1914).

BRITISH WALNUT.—This varies very considerably in quality, texture, and colour, according to the place and soil on which the trees grow; and a much larger proportion of finely-figured, good-coloured British wood can be obtained than is usually recognised. A particularly finely-figured tree of rich colour, which, I was informed, grew on Mr. Harcourt's estate, was sold and sent to America a few years ago. The figure, quality, and colour certainly equalled, if it did not surpass, anything which has been found elsewhere in Europe. The tree, originally sold in England for a moderate price, produced thousands of feet of veneer which is now adorning some beautiful rooms in America, where it has realised a total value of well over £1000 sterling. A polished panel made from it by the American cabinet-maker is at The Lynch House, Totteridge, Hertfordshire.

Notwithstanding the disadvantages referred to above as to the use of walnut in some kinds of work, it remains one of the most valuable of timbers, and having in mind the world-wide demand and universal depletion of supplies, the planting of walnut trees should have an important place in any future schemes of reafforestation.

CAUCASIAN WALNUT.—Although in England Italian walnut has always held the reputation of being the finest in quality, colour, and figure, yet by far the largest quantity of the best wood in all respects has come from the Caucasus. That imported from Circassia has been the best, and especially that Circassian which actually came from the district of Poti. This supply of late years has been much reduced, and most of the so-called "Circassian" walnut has in reality been Georgian, Mingrelian, Imerethian, Gourian, and Abasian, all being districts much farther east and farther distant from the sea coast. The traders in the wood in these countries have been generally very astute, and it has been exceedingly difficult, unless the trade has been carried on by Englishmen, to discover the real source of the supply, and as a result many disputes and difficulties have occurred which resulted, in one case at least, in a law-suit. Every year the supplies become scantier, while the quality deteriorates, so that the walnut of the better class will soon become unobtainable, unless some new source of supply be found. As is the case with most other valuable figured woods, by far the greater part of the best walnut has found its way to the United States, where it is much appreciated for decorative panelling or " trim " and for furniture and pianos. The practice there is to select the better figured logs, which are sawn into flitches, or large-sized planks, and placed in a steaming chamber, and when thoroughly steamed, fixed on to a knife veneer-cutting machine. They are then either cut straight through or on the half round on a rotary cutter, the last-named producing wider veneers. The remainder of the logs are sawn into boards and so forth (which in America are called lumber), and used for more ordinary " trim " or cabinet work.

Without the examination of a great many samples of each kind it is impossible to distinguish any structural features characteristic of the woods of different countries, for in one and the same country the wood varies considerably both in this respect and also in weight.

In general, in transverse section the annual rings are rendered visible by the sparcity and slightly smaller size of the vessels (pores) in the outer part of each ring; in the spring-wood the pores are large and scattered and do not produce a sharply-defined pore zone. With the aid of a pocket lens (12 ×) the fine medullary rays are rendered visible, as are fine, concentric light lines (of soft tissue) joining them at right angles.

French Walnut.—This wood is for the most part light-coloured and straight-grained; the relatively small amount of finely-figured French wood available is practically all absorbed by Paris and Marseilles for veneers. In recent times a great amount of decorative architectural work has been executed in plain French walnut, the quiet grey colour and straight grain of which produces a dignified and restrained artistic effect and particularly suits the modern styles of cabinet work.

Italian Walnut.—While this is most generally named in architects' and other specifications, it is actually very rarely obtained. Formerly it included a large proportion of dark-grained and figury wood, but of late years supplies of all kinds have been greatly reduced, and the quality in all respects has much deteriorated.

Spanish Walnut.—A regular but not large quantity of wood has been imported from Spain. The general quality and conditions are the same as the French, from which it is difficult to distinguish it, except that on the whole the shipments have consisted of sizes more irregular in width and length, and containing more faults, with a much larger percentage of sap-wood.

TURKISH WALNUT.—This most nearly resembles the French walnut, but it includes a greater proportion of figured wood.

WALNUT, AFRICAN. *Lovea Klaineana,* Thompson. Weight, 30 lbs. 12 oz. West Coast of Africa.

This wood is shipped, usually mixed with consignments of mahogany, from all the ports on the West African coast. The logs are generally of large sizes, 8 to 30 feet long and 18 to 40 inches square, and are at times of even larger dimensions. They are also received in the round, either with or without the bark. The wood only resembles walnut in its colour and by the fact that it shows the same streaks of veins which are prominent in the true walnut (*Juglans regia*). This is probably the reason why the incorrect term of walnut has been applied to it in the timber trade. In all other respects, such as formation, grain, weight, texture, and figure, it resembles African mahogany. The logs vary in character, those from Cape Lopez being almost entirely plain and straight-grained, while from Benin and Lagos the larger portion of the wood is strongly marked with stripes or roe, which, though sometimes straight, is more often broken up into an irregular growth showing black lines which curve and twist into fantastic shapes. These form what is termed " blister " or " snail " figure, while other unusual markings also occur. The colour is somewhat similar to that of French walnut, but is more variable ; sometimes the wood is of a darker brown, but it nearly always has a golden tinge. By careful selection a yellowish-brown golden tint can be obtained which is quite unique. It is easily worked, and is not wasteful in conversion, as is most European walnut. The logs provide long lengths and good widths free from defect, so that without difficulty panels can be obtained up to 2 feet 8 inches and even 3 feet in width.

Although up to the present African walnut has been procurable at a low cost, few have discovered what a handsome decorative wood it is. Mr. Leonard Stokes, a former President of the Royal Institute of British Architects, has used this wood for many important buildings, amongst which is that of Emmanuel College, Cambridge. All of this beautifully designed work is left from the tool without polish, and has a very fine appearance. Mr. Stokes also designed a room in this wood for Lord Digby, which has been much admired. Mr. George Miller has had his library at Newberries, Radlett, Hertfordshire, furnished and panelled with it. In this case a dull brown polish has been used, the result being a most handsome and effective appearance. Richly figured curls or crotches have been obtained from these logs, some of which have been converted into large panels and used for decoration on the P. and O. line of steamers, the rails and stiles being of the plainer variety of the same wood. It has been used with success for the interior decoration of automobiles. Handsome floors can be laid in the wood, and as flooring it both wears and keeps its colour well. Only a small proportion of the logs provide sufficiently handsome timber for decorative work, and it should not be assumed that the name of African walnut alone will ensure a satisfactory result, that being only obtained by careful selection. It should be a very good substitute for French walnut for aeroplane propeller blades and rifle butts, for when seasoned the wood stands very well and is not brittle.

The transverse grain shows irregularly-sized scattered pores. The medullary rays are parallel but uneven; the annual layers of growth are so obscure as to be almost untraceable.

WALNUT, BLACK. *Juglans nigra*, Linn. Weight, 37 lbs. 7 oz. North America.

This wood is so familiar in this country that a detailed description would almost appear to be superfluous. The colour, which is of a more uniform tint than is the European wood, is a rich purplish-brown. The beauty of the colour is apt to deteriorate under the unfortunate and ill-advised system of french polishing which obtains in this country, which, though admirable for some woods, is quite out of place with black walnut. The texture is hard and smooth and the grain generally straight and even, though occasionally it displays all descriptions of beautiful figure. A limited quantity of burrs are still obtainable, which realise extraordinarily high prices. Black walnut is in good demand for all descriptions of decorative cabinet work, and for telephone instruments it is used almost exclusively. It possesses, though in a lesser degree, those exceptional qualities found in European walnut (*q.v.*) which give the wood its pre-eminence in the making of gun and rifle stocks.

The use of this wood for decorative work is of considerable antiquity, and probably dates from the time of the early settlement of English people in America. For instance, at Totteridge Park, Hertfordshire, which in the early eighteenth century was in the possession of James Bridges, first Duke of Chandos, are some doors of that period which have been found to have been made of American black walnut of very high quality.

At this time also a considerable number of trees were planted or grown from seed in many parts of the United Kingdom. No American timber could be bought of a better quality than that (quoted by Mr. H. J. Elwes) of a tree blown down at Albury which was given to him by the Duke of Northumberland.

During the European War black walnut, besides being largely used for rifle stocks, was employed to a great extent for propeller blades for aircraft work. The demand was so great that supplies rapidly diminished. A movement was set on foot at Washington, however, to appeal to owners of such trees throughout the country to sell the timber to the Government in order to aid in the more vigorous prosecution of the war. This scheme was carried out with great success, and a sufficient supply became available both in America and in this country. A similar plan took place in England with regard to English ash (*q.v.*).

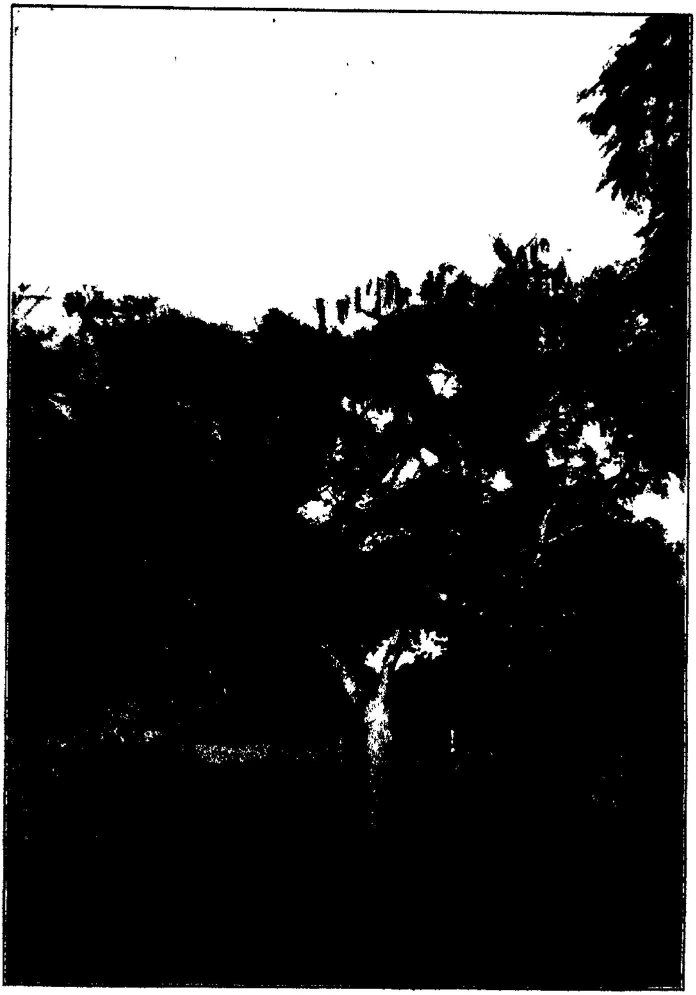
The pores are very irregular in size, and are evenly distributed. They are larger in the spring growth than in the autumn, and this variation causes the concentric layers to be distinctly marked. The medullary rays are clear and fine cut; they are somewhat irregular, and are crossed at right angles by innumerable fine lines, the whole presenting a pattern as of lace work. They show on the radial section in very fine, light-coloured flecks.

WALNUT, EAST INDIAN. *Albizzia Lebbek*, Gamble. Weight, 47 lbs. (Troup); my sample, 65 lbs. India.

This timber is known in England by the name of East Indian walnut, but in Burma and the Andaman Islands it is called "kokko." It is not quite clear whether the shipments of East Indian walnut, most of which has been sent to America, have been the produce of *Albizzia Lebbek* only, or that the produce of *A. procera* and *A. odoratissima* have also been included with the consignments.

It is a hard, dense, close-grained wood of a dark brown colour, with black and grey streaks. It usually has a curly, wavy grain, often containing the characteristic figure of mahogany, which is commonly known as roe and mottle; it sometimes has a very pronounced and strongly-marked fiddle mottle. When planed it has a fine, glossy and rather lustrous surface. It is imported in logs hewn square, in lengths of from 8 to 20 feet and in squares from 16 to 30 inches, with waney edges. "It seasons, works, and polishes well, and is fairly durable. It is used for sugar-cane crushers, oil-mills, furniture, well-curbs, and wheel-work; in South India for boats. In the Andamans, where trees of large size are procurable, it is used for building, but more usually for house-posts" (Gamble).

A small quantity has been used for decorative furniture work in England, but it is not yet very generally known or appreciated. It has been used very effectively for parquet flooring. The dining-room at Government House, Port Blair, in the Andaman Islands, which was panelled in East Indian walnut twenty years ago, is still in splendid condition, as is a magnificent partition screen carved by convicts, which was erected at the Club House, Port Blair, twenty-two years ago. In a letter from Mr. G. R. Keen concerning the use of this wood, he speaks



Photograph by T. B. Chitrekar.

EAST INDIAN WALNUT (*ALBIZZIA LEBBEK*) IN FRUIT.

of its admirable effect and smooth mellow appearance being due to the peculiar properties of the wood. In America it has been largely used for decorative work and furniture, especially by the Pullman Car Company in coaches, restaurants, and smoking carriages, where it presents a very handsome appearance. In that country, however, it is known by the names of koko and laurel-wood. It is specially adapted for use in veneering, and it is a good wood for turnery.

With the growing scarcity of European walnut it should become much appreciated for decorative work in England, as it possesses high-class qualities similar to that wood. It is not, however, suited to some of the purposes to which European and American walnut is put; for rifle stocks, for instance, it is too hard, brittle, and heavy. For this purpose the product of *A. procera* (*q.v.*) is more suitable.

In working the timber of the three species named above it has been sometimes found that the dust causes the workmen to sneeze.

Under the lens a light and dark concentric ring can be clearly seen. The medullary rays cannot be discerned. The pores are irregular in size and position.

WALNUT, MANCHURIAN. *Juglans mandschurica*, Maxim. Weight, 32 lbs. Manchuria.

This walnut resembles the European walnut (*Juglans regia*), but is generally milder and straighter in the grain. It is more of a yellowish-brown in colour, and there is a marked absence of the light and dark streaks which characterise the European walnut. According to the information at present available the trees are, unfortunately, all small in girth and consequently only provide narrow widths, which will militate against the wood as a timber for export. Like other walnuts it stands well under all conditions without warping or twisting.

The annual rings are clearly marked. The pores, somewhat irregular in size and arrangement, do not form any definite pore-zone. The fine medullary rays and thin light lines joining them at right angles come into view as in European walnut, when the transverse section is examined under the lens.

WALNUT, SATIN. *Liquidambar styraciflua*, Linn. Weight, 37 lbs. 7 oz. North America.

In England this wood has also been variously named hazel pine, red pine, grey pine, and Californian red gum, but in America it is known as gum, sweet gum, or red gum. All the English names have probably been given for commercial reasons, as the wood has never been so favourably received as the exporters would wish. It fills, however, a very important place in the timber supplies of America, where the climatic conditions prove more suitable for its preservation than do those of the United Kingdom.

It is of a light reddish-brown colour with dark streaks, and possesses a certain lustre. In seasoning it shrinks unevenly, and even after ample time has been allowed for the process it will, in this country, continue to expand and contract with the variations of the climate. An experimental piece sawn fresh to 9 inches by 3 inches on the quarter, shrank on the heart side to 2½ inches and on the other side to 2¾ inches. In seasoning also, the hard grain will remain and the soft grain sink, causing an uneven surface. Unless cut on the quarter it is very liable to warp and twist.

It has been used in England for cheap furniture and furniture linings, and to a small extent for the trimming of railway and other coaches and carriages. It was introduced into London some years ago under the name of Californian red gum and used for street paving; a large area, including Waterloo Place and Whitehall, being laid. However good for such a purpose in another climate, it is undoubtedly quite unsuitable for this country. The results were disastrous, causing very considerable newspaper and other agitation, followed by law-suits; very shortly after, re-pavement of the various areas became necessary.

The pores are very numerous and, like the medullary rays, are ill-defined and obscure.

WANA. *Nectandra Wana*, and possibly *N. Pisi*, Miq. Weight, 64 lbs. 2 oz. (wet). Surinam (Dutch Guiana).

This wood is also called Surinam mahogany and cirouaballi. It is of a light-red mahogany colour, and much resembles the African mahogany in grain. It is also similar in texture, though a little coarser and rougher. It was unknown in the United Kingdom until 1914, when a shipment of 137 hewn logs were diverted from Havre to London on account of the war. The timber proved to be clean, straight, and sound, although somewhat defective in the heart. It works well, but does not easily take a nice finish from the tool. The sap-wood on the outside of the logs was much perforated with small worm-holes. A large quantity of this wood has been used as a substitute for Dantzic pine for the roof timbers of a church at Plymouth, and appears to be wearing well. As long lengths and large squares can be produced, it should prove in the future to be a useful timber for many purposes.

The pores are numerous, evenly distributed, but not very open. The medullary rays are regular, parallel, and fairly even.

WANDOO. *Eucalyptus redunca*, Schau. Weight, 70 lbs. Western Australia.

A local name for this wood is white gum. Julius gives the following report:

"Trees of average size attain the height of 60 to 80 feet, with an average diameter of 2 to 3 feet. The timber is brownish-red in colour, very hard, dense, strong and durable. . . . For railway sleepers . . . is deemed to rank equal to jarrah, and is also used for short piles and for bridge and wharf planking, etc., in permanent works when conveniently procurable. It has been, and continues to be, freely and very successfully employed for both wheelwrights' and millwrights' work, for which its extreme hardness, especially when seasoned, is particularly appreciated. It is used for ribs, bends, and knees in lugger and boat-building, (and) for mining timbers; while it serves to provide very durable fencing, stockyards and other settlers' wants. . . . As in other Eucalypts, the heart-wood core is to be avoided. Specifications for cut timbers should therefore require freedom from heart-wood, except in the case of piles, which are better round than squared.

"With regard to the durability of wandoo, the Railway Department, in reporting the result of sleepers laid on the Newcastle [Western Australia] line as a test, states: 'About 150 of these were put in about seventeen or eighteen years ago when the line was constructed. Fully 90 per cent of them are, to all appearance, as good as new, being very hard and sound, and they will in all probability last yet for many years. A few of the sleepers were slightly decayed on the outside, but on scraping off about a quarter of an inch the remainder of the timber was found in each instance to be perfectly sound. . . . The wood is not liable to attack by dry rot unless under conditions exceptionally favourable to its development.' "

C. E. Lane-Poole says that "its main use, however, is for waggon scantlings for the railway stock for the Government Railways of the State. It gives a life of twenty-five years in under-carriages of trucks. The top plank of these trucks is always made of wandoo, which stands the wear of the loading and unloading better than steel; also the stanchions of the trucks are of wandoo. A remarkable quality which this timber possesses is that when used in conjunction with steel there is no chemical action between the wood and the metal. Bolts have been taken from the under-frames of trucks after twenty years' use, and been found to be quite as clean as when put there, while the auger marks were still visible in the holes."

WASHIBA. Source unknown. Weight, 55 lbs. (Stone). Guiana, Guadeloupe.

Stone describes the wood as a beautiful red, splashed with yellow, the grain moderately fine and open, and the surface rather lustrous. It is exceedingly tough and elastic, and is used for bows and fishing rods. It will square 30 inches free of sap-wood, by 20 feet long.

This authority appears doubtful as to the correct name and identity of the wood.

WATTLE, SILVER. *Acacia dealbata,* Link. Weight, 47 lbs. (Gamble). Tasmania.

Tasmanian Timbers says of this wood that " It produces a somewhat porous timber of a dark-brown to a yellow-brown colour, easily split, fairly tough, and used and exported chiefly for cask staves. It is occasionally used for furniture, and when polished has a very handsome grain."

Gamble mentions that this tree was introduced in India in 1840. He describes the structure as follows: " Wood moderately hard, light red. Pores moderate sized, often in short linear groups surrounded by pale rings. Medullary rays short, fine, and moderately broad, well marked on a radial section."

WHITEWOOD. *Liriodendron tulipifera,* Linn. Weight, 28 lbs. 10 oz. North America.

This very important timber has been used for a vast number of purposes in the United Kingdom, America, and elsewhere. One of the most majestic of trees, it provides in that season of the year when it blooms a most imposing and impressive sight: the eye ranges along a great mass of wide-spreading foliage, while the tree top is clothed in innumerable tulip-like flowers. Scattered about in England are many beautiful specimens which our forefathers, with a greater appreciation of the effects of arboriculture than, alas! is found to-day, planted around their dwellings and in their parks.

The timber is known in England as " whitewood " or " canary whitewood " ; in Scotland and England sometimes, though incorrectly, as " basswood," and in America as " poplar." The colour, when the wood is fresh cut, is canary yellow, sometimes with rather a bluish tint deepening and toning down with exposure to air to a light yellowish-brown, with a satiny lustre, which is probably caused by the countless small specks of bright, shining gum which glisten on all sections. It is mild, easy to work, silky in grain, and capable of a very smooth surface from the tool. Having been available in very large quantities, in long lengths and wide widths of beautiful quality at a cost far below its real value, it has been extensively used for all kinds of joinery and cabinet work, fittings and similar work.

It requires time to season thoroughly, and shrinks considerably, but when properly dried, stands well under all conditions. It also finishes with a sharp edge, which renders it a good wood for mouldings. It is *extensively used in America, and, to a more limited extent, in the United Kingdom for ply construction. A few trees are found possessing* a curly grain; they are generally cut into veneer, on a rotary veneer cutter round the log, producing a marking which is called "blister figure." These figury veneers are used for panels for decorative work in railway coaches, state-rooms and saloons for yachts and steamers, and for general cabinet work.

The numerous pores are very small and regular. The medullary rays are uniform, distinct, and parallel, showing in small flecks on the radial section in a very even and artificial-looking pattern.

WILLOW, EUROPEAN. *Salix cœrulea*, Smith; *S. alba*, Linn. Weight, 24 lbs. 12 oz. Europe.

The well-known "bat-willow" is famous wherever the English language is spoken, and is so familiar that it seems almost superfluous to give a description. Although it always commands such a high price for bat-blades, and the demand is so large, it possesses many valuable characteristics which should encourage every forester to plant the tree wherever it can thrive. For bat-blades trees have been known to realise as much as 10s. 6d. per foot cube or more. No other wood has been found which can be used to such advantage for artificial limbs. The tree trunk itself, or squares sawn out if the size be large enough, can be shaped and hollowed to the form of the limb, and although during the process, or when drying, it does occasionally split, it will generally stand. No other wood has been found that will satisfactorily pass this test. A considerable quantity was imported from America during the war. The American artificers who during the war were in charge of the artificial limb factories at Roehampton called the wood they used "red willow." I have been unable to trace the actual species, but I cannot distinguish it from the English bat willow. Owing to the wood denting instead of splitting when struck by heavy objects, it is valuable for linings for carts, barrows, brakes for railway and other waggons. It is especially good for the last-named purpose, as it does not fire so readily as other woods by the friction of the wheels. Elwes and Henry say that the best class of bat-blades is obtained from *Salix cœrulea*, *S. Alba* producing blades of an inferior kind. The report adds: "G. W. Newton states that George Stephenson had a high opinion of willow as forming durable blocks for paving. Gorrie states that 'in roofing, it has been known to stand one hundred years as couples, and with the exception of about half an inch on the outside, the wood has been found as fresh at the end of that period as to be fit for boat-building.' Boards of willow were laid for floors in 1700."

Willow has been tried for aircraft construction at the Royal Aircraft

Factory with quite satisfactory results, but it is doubtful if sufficient supplies in the necessary lengths and sizes of straight-grained timber free from knots could be obtained to make its use practicable.

The numerous pores are exceedingly small. The medullary rays cannot be distinguished with the magnifying lens (12 ×).

WILLOW, JAPANESE. *Salix Urbaniana*, Von Seeman. Japan.

The Japanese name of this wood is Tokachiyanigi. It is obtainable in logs ranging from 12 to 20 inches in diameter, averaging about 15 inches. The wood is reddish-yellow in colour, with a white to straw-coloured sap-wood; it is closer and finer in texture and grain than the English willow. It takes a smooth surface from the tool, and would make a good substitute for the latter for bat-making. It would also be suitable for aircraft construction, possessing as it does the same qualities as the English wood. It is very similar to this, but the colour is slightly browner, and the annual rings are much closer.

The concentric layers are well defined, the pores are not very numerous or large, and the medullary rays are obscure. On the tangential section the pores shine with minute particles of gum.

YACAL. *Shorea* sp. Weight, 62 lbs. 4 oz. The Philippines.

A shipment of fine, clean, faultless planks of this timber came to hand shortly before the war, and as its undoubted good qualities were unknown, it was sold at an exceedingly unremunerative price. The wood is of a light yellowish-brown colour, with a firm, hard texture and close grain. It is very durable and reliable under all conditions, and would be much in demand if it were better known. According to Foxworthy, "yacal seems to be supplied by *Shorea balangeran*, Burck., and other species of *Shorea*. Some of it is also supplied by *Hopea odorata*, Roxb., and other species of *Hopea*. Large quantities . . . are used in the Philippines for railroad ties. Perhaps the largest place of export for the wood is British North Borneo. . . . A very excellent, durable wood which is said to be free from insect attacks."

The pores are of moderate size, generally plugged with glistening gum, and are disposed in groups forming a pretty pattern. The fine, clear-cut medullary rays, which are parallel, are very numerous, and are joined at wide intervals by a faint light-coloured ring which follows the line of the concentric layers.

YANG. *Dipterocarpus tuberculatus* (?). Weight, 42 lbs. 7 oz. Siam.

The resemblance of this wood to eng is so strong that one will pass for the other. It has been claimed that yang is better than eng, and *vice versa*. In general, it may be possible that yang is slightly lighter in colour, otherwise it is difficult to name any difference, and for description it will be well to refer to the section on eng.

Yate. *Eucalyptus cornuta*, Labill. Weight, 71 lbs. (at 12 per cent moisture)—*Official Handbook*. Western Australia.

Lane-Poole, in his handbook *Quelques Aperçus sur les Bois de l'Australie Occidentale*, writes of this wood: "This species yields a light-coloured timber of exceptional strength. It is probably the strongest timber in the world, and in one test for tensile strength the breaking load was 17½ tons per square inch, 3½ tons less than that usually specified for wrought iron of ordinary quality. It is used for wheelwrights' work generally, and is preferred where the strongest shafts for frames of carts are required."

Yellow-wood, African. Source unknown. Weight, 20 lbs. East Africa.

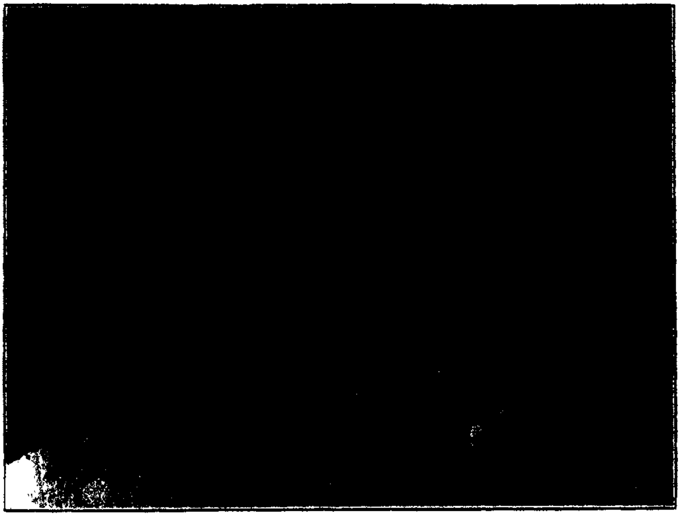
This timber is also known as African pine. It has not yet been imported commercially into the United Kingdom, but is likely to be so in the near future. It is of a dirty yellowish-straw colour, with streaks of darker brownish-black. It is straight-grained, very light in weight, is close and compact, and capable of a smooth surface.

On the transverse section even a sharp plane produces a broken fibre, and it is difficult to distinguish either pores or medullary rays.

Besides the above, the names of Natal yellow-wood and upright yellow-wood, both of which are a species of *Podocarpus*, have been used, but as there has been no commercial import, and the wood is practically unknown in this country, the source of my specimen is doubtful.

Yew, British. *Taxus baccata*, Linn. Weight, 48 to 50 lbs. (Baterden). Europe.

This useful and highly decorative wood is now little known or esteemed, although it possesses qualities which deserve much better recognition. If the economic use of domestic woods were practised in this country as it has been in France and Germany, yew would have undoubtedly been brought into prominence. The colour is a pale red, somewhat like cherry-wood or pencil-cedar; it has a beautiful, smooth lustrous grain. It is sometimes handsomely figured, and occasionally has a burr growth, the produce of which will compare favourably with amboyna, and has indeed actually been mistaken for it. The strength and elasticity of yew-wood has been known for centuries, particularly on account of its use for bows in this country. It also makes a good golf shaft, although its strength is not quite equal to sustaining the sudden shock of the striking blow as does hickory, for example, so that its life is not so long as is that of a hickory club. Yew is particularly suited to the purpose of chair-making, and some very fine specimens of considerable antiquity are to be found in many places. Such a chair is to be seen in the Apothecaries' Hall (Society of Apothecaries of London) in Water Lane, Blackfriars. Elwes and Henry allude to an extremely handsome arm-chair in Hornby Castle, the property of the Duke of Leeds. "The date is about 1550. It is made of yew, which adds to its rarity, for up to this time it was practically penal to employ yew-wood for any other purposes than the manufacture of the national weapon; in this instance the wood has become close, as hard as steel, and of a beautiful dark amber colour." The wood, though difficult to obtain, is also valued for brushwork.



An exceptionally large and fine Yew Burr from the Caucasus.
It measured over 7 feet in length.

The timber is so good that it deserves the full attention of forest economists, who should plant the tree for the use of future generations.

Yew, Caucasian. *Taxus baccata,* Linn. The Caucasus.

This wood is imported in short hewn logs, from 7 feet to 10 feet in length and 14 inches to 28 inches in width. It is similar to the British grown variety, but is a little denser and harder in grain. It has been used for brushwork, and for this purpose has occasionally been imported into Liverpool from the Caucasus. In 1911 one of the finest burrs I have ever seen was shipped to London from Batoum. This burr weighed nearly one ton and was magnificently marked. It was purchased by an American and sent to Paris.

ZEBRA-WOOD.

While this name is usually applied to the marble-wood of the Andaman Islands (*Diospyros Kurzii*), *q.v.*, it has also been given to certain small parcels of wood which have from time to time been seen in the English, French, and German markets. Nothing authentic is known of the sources of these supplies, and as a commercial proposition they are negligible. Stone and Freeman, however, refer to a "zebra-wood" of British Guiana as *Connarus guianensis*, Lamb., or *C. africanus*, Lam., and there is little doubt that many years ago "zebra-wood" was imported from Brazil, Jamaica, and the West Indies generally, and perhaps also from New South Wales and elsewhere, but the various species of the wood were unknown. In commercial practice, however, it seems that any striped wood of bright colour has been given this name.

Zizyphus Jujuba, Lam. Weight, 48 lbs. India.

The wood of the "jujube" tree very much resembles a plain, straight, even-grained piece of black walnut (*Juglans nigra*, Linn.), though it is slightly lighter in colour. The evenness and regularity of the grain, and its evidence of good standing qualities, should recommend it for important cabinet and other work. Gamble reports it as "universally used for saddle-trees, also for agricultural implements, sandals, bedstead legs, tent-pegs, golf clubs (Chicago Exch. Cat.), and other purposes." Troup mentions its use for gun-stocks, for which its qualities would appear strongly to recommend it.

The pores are very small and are surrounded by a pale halo; the concentric layers are very clearly marked. The medullary rays are hardly discernible under the lens (12 ×).

THE CONVERSION AND PRESERVATION OF TIMBER

To obtain the best results, all kinds of timber should be converted immediately the tree is felled, or as soon afterwards as the circumstances permit. By leaving the tree lying on the ground it will not automatically become seasoned, or indeed be any better fitted for use. If the bark remains on the tree, the latter as it cracks at the ends is liable to be stained by the bark, which by degrees falls off and exposes the bare wood to sun and wind and all variations of the weather. Insects attack it from all points, laying their eggs in the bark and in the splits and cracks which develop on the ends and sides; when these occur they will not close again, and will seriously impair the value of the wood. Fungus also naturally develops, the result being that the tree becomes only a large piece of decaying vegetation. The loss which ultimately occurs in conversion is greatly increased, and the damage done by the insects and fungi results in harm which may be discovered early or perhaps be unsuspected till years afterwards, when the converted product has been used in its ultimate position.

The trunk should, therefore, be sawn at once into the logs, planks, boards, and scantlings which will eventually be required, or if the exact size be unknown, then to the nearest likely dimensions. In the past it has been customary in some cases for engineers and architects to specify that the timber shall have been felled for at least five years, or for some less period named. Such a requirement is mistaken, and is not likely to yield the desired result.

It is necessary to have a clear idea as to the meaning of the term "seasoned," as applied on the one hand to a piece of wood small in thickness, and on the other to a log or beam. The small piece when seasoned is more or less dry from the outside to the core; whereas the wood of the "seasoned" log is by no means necessarily so. This latter fact is rendered comprehensible by a consideration of the sequence of events during the seasoning of a log. While this lies exposed to sufficiently dry air, it loses water by evaporation, which takes place over the whole surface, but most actively at the two ends; when the bark is left on the log, evaporation is excessively slow, save where there are cracks. As the moisture is lost at the surface, the drying superficial wood receives water from the interior, but sooner or later a time comes when it receives less than it loses; the log then, when protected from outside moisture, assumes a condition in which it is relatively dry externally and relatively moist in the middle. This condition may endure for years, possibly for centuries in the case of dense woods: for instance, thick walnut trunks when cut open after being stored indoors for years are found to be thoroughly wet in the middle. Even if such logs are described as seasoned, their wood cannot be so described. If the log be cut up, the resulting pieces, including the centre wood, being moist, will shrink and are liable to warp and split in the same manner as similar unseasoned pieces. Yet such "seasoned" logs or large beams are very different in properties from freshly-felled specimens. This is clear when it is remembered that:

(1) Deformation, warping, and cracking are, in the beginning, caused by unduly rapid drying at the surface.
(2) Dry wood is stronger than wet wood, and in mechanical structures the important matter is to have the external part strong.
(3) Wood-destroying fungi causing rot, gain entrance *solely* through moist wood.
(4) It is possible that wood seasoned slowly is superior in mechanical properties to wood rapidly seasoned (it is also certainly less liable to split during seasoning).

Thus the "seasoned" beam used as such, or as an upright for internal work, is stronger, less liable to deformation, splitting, and decay. Yet it is obvious that logs or large beams thus seasoned are superior as a whole to fresh wood only under circumscribed conditions and for special purposes. If the wood is to be used whole out-of-doors, in a moist climate, it may often be inferior to unseasoned wood because it will be more liable to swell and undergo deformation and splitting. Again, if it be subsequently cut into thin or small pieces, and these be used at once for internal work, the wood is far inferior to such pieces seasoned in their small state.

Laslett, who had wide and prolonged experience, wrote: "The most effectual way to preserve good timber is to partially season it in as natural a way as possible before working it up, and to give it simply the protection when brought into use which all other materials require to keep them from perishing. . . .

"My experience of the approximate time required for (partially) seasoning timber under cover, and protected from wind and weather, is as follows:

Dimensions of the Cross-Section.	Time required in Months.	
	Oak.	Fir.
24 inches and upwards square . . .	26	13
Under 24 inches to 20 inches square . .	22	11
„ 20 „ 16 „ „ . .	18	9
„ 16 „ 12 „ „ . .	14	7
„ 12 „ 8 „ „ . .	10	5
„ 8 „ 4 „ „ . .	6	3

"Planks from one-half to two-thirds the above time, according to thickness.

"If kept longer than the periods named, the thin fine shakes which first open upon the surface during the process of seasoning will open deeper and wider, until they possibly render the logs unfit for conversion. If, however, the logs be reduced to the scantlings required after partial seasoning, and then further allowed to dry, they will not be liable to tear open so much, but by shrinking gradually will retain a more solid form, and be less objectionable to the eye when placed in position."

In the case of pieces of wood less massive and thinner than the logs and large beams already considered, the important matter is that the wood shall be adequately seasoned, and free from cracks and other defects. There is evidence that wood first partially seasoned in bulk, and then fully seasoned after being sawn, is much inferior to that which is felled, brought straight to the saw-mill, sawn at once, and then seasoned. It is far more economical to season boards and small pieces in the latter manner by artificial seasoning. When very large pieces are required, such, for instance, as have been used in the restoration of the roof of Westminster Hall, it is necessary, in order to obtain them in any respect seasoned ready for use, that they should either be sawn out of fresh-felled logs and then placed under cover for as long a period as possible before use, or, if this is impossible, that they should be placed in position as they are. It is a mistake to suppose that any good results from the effort to obtain such pieces from trees which have been felled some years previously; while for this class of work considerable time can, as a rule, be allowed for its execution.

After conversion, the planks and scantlings should immediately be carried to a shed the ground of which has previously been carefully prepared, while the choice of situation is also of importance. While a free current of air must be allowed, the timber should not be subjected to any excessive draught, nor should it be exposed to the rays of the sun, and it is essential that all wet should be excluded. The ground should be level and sufficiently hard to bear the weight of the proposed pile.

If possible, concrete bearers with not less than 2 feet centres and having a level surface should be laid down at intervals, otherwise baulks of timber should be used which are sufficiently strong to support the pile, and thick enough to allow a good current of air to circulate under it. The planks and so forth must then be laid down and "sticks" inserted between each layer.

These sticks should consist of thin pieces of wood which will not stain *the timber. They should be of even and regular thickness, not less than a full ⅞ inch in the lower tiers,* and about ⅝ inch in the upper. Great care must be used to see that they are placed exactly above each other at even and regular distances according to the thickness of the planks which have to be piled. Sticks ⅝ inch thick must be placed at intervals of not more than one foot apart, while for thicker planks they may be extended to a distance of as much as 30 inches. The distances between the sticks should be varied according to the character of the wood; and whether it is important to find it flat and level when taken from the pile after seasoning.

Broad widths of hardwoods are dealt with in a different manner. The planks or boards should, after sawing, be "cleated" with hoop iron bands secured with two nails at either end of the wood (as illustrated in Fig. *a*). The common custom of cleating with a stout piece of wood (Fig. *b*) is wrong. The liability to split is much greater during the early stages of sawing and seasoning, for when the boards or planks have become dry there is little risk. During this period the iron bands hold the wood together, and as the latter shrinks, begin to buckle outwards (Fig. *c*). If the planks should split, the wood is held firmly so that the split will not extend (Fig. *d*). On the other hand, the strong wooden cleat holds the end of the board or plank firmly, and when this begins

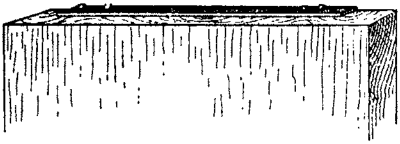


FIG. *a*.—Hoop iron cleat, fresh nailed.

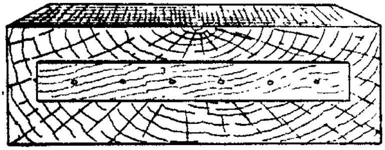


FIG. *b*.—Wooden cleat, fresh nailed.

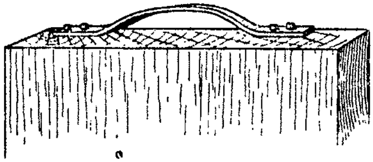


FIG. *c*.—Hoop iron cleat, seasoned and sound.

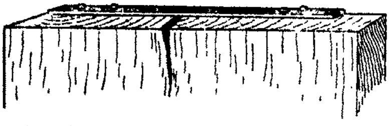


FIG. *d*.—Hoop iron cleat, seasoned and split.

to shrink, actually causes it to split because the cleat will not give way (Fig. *e*). Thus a plank 20 inches wide which may shrink one inch when dry will perforce have a split in it to the same extent.

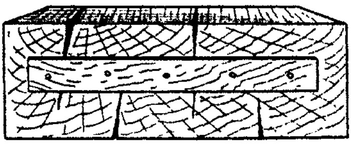


FIG. *e*.—Wooden cleat, seasoned and split.

All kinds of timber until properly seasoned, and even sometimes afterwards, are very sensitive to climatic conditions, and rapidly record every change which occurs. Care should therefore be taken to choose a position where the timber will not be exposed to rain or sunshine, to continual damp, or to cold and dry winds. During the earlier stages of seasoning any of these conditions will damage the wood to a very considerable extent.

The time required to season timber properly varies so greatly according to the different kinds and sizes and the position in which they are placed, that it is almost impossible to lay down any general rule. A very rough manner of reckoning has been general, which allows one year for each inch of thickness, but this is not reliable. The table given by Laslett, previously quoted, can only be accepted as a rough estimate for large sizes. It is necessary, therefore, to consider each case separately, and examine every parcel by itself. If high-class work is desired it will probably be found necessary to subject the timber to a process of artificial seasoning. This important question is, however, fully dealt with elsewhere (see p. 385).

It may be interesting here to mention that before the war many very successful works were completed in mahogany, Japanese oak, and other hardwoods, in which artificially seasoned wood was used. In the case of the oak, the entire work of a very handsome building was completed by the use of fresh logs, sawn, dried, and made into panelling in less than three months from the date of the arrival of the steamer with the cargo. This, after nine years (1919), shows no trace of any shrinkage or other fault, and the expert who has seen it finds it difficult to believe that such a result could be obtained.

A system was invented by Mr. H. J. Powell which is known as Powellising; this consists of boiling the timber in a saccharine solution without pressure. It is claimed for this process that, besides being a preservative one, preventing dry rot, and rendering the timber termite-proof, it improves the texture of the wood, which is completely seasoned in a very short space of time. Mr. Walter Birch of High Wycombe has certainly accomplished some remarkable results. For instance, four pieces of English oak were cut from the branches of a tree into a thickness of 1½ inches. These branches from the green, wet log were sawn out, processed, and jointed in four places in twenty-one days. From them was made the seat of a chair which, finished in the spring of 1913, holds perfectly sound and shapely now (1919).

In many buildings it is commonly found that there exist cracked ceilings, shrunken skirtings and floorings, warped panelling and doors, and window frames which rattle and will neither open nor shut without the application of undue strength. These results are all generally caused by the use of improperly seasoned material.

The time that the tree is felled has also an important bearing on the subsequent appearance of the timber. A most interesting note on this subject has been written by Mr. J. C. Wickliffe, the principle of which, while it particularly concerns the felling of prima-vera trees, may possibly be applied to other woods. Mr. Wickliffe writes:

"At one time during my residency in Spanish Honduras, between the years 1903 and 1908, I determined to see if there was anything in connection with the felling of the prima-vera tree which had an effect upon its marketability. I had heard the natives say that any timber should be fallen 'in the dark of the moon.' Like many, I at first charged it to superstition; but, being faced with the inexplicable fact that the fly-worm seemed to attack some trees more savagely than it did others, I determined to see if there was not something beyond superstition in the common saying of the native. Consequently, I selected two prima-vera trees standing side by side and apparently of equally vigorous growth and identical condition. One of these trees I had fallen in the early part of the month, at which time the moon was on the increase, and the other in the latter part of the same month, when the moon was on the wane. I allowed these two trees to remain for some three weeks after the last had been fallen, and then visited them. One tree, the one fallen last, as I recall it, showed a ring of congealed sap (about ¼ of an inch thick) between the sap and the heart-wood, and it had been attacked but little by the fly-worm (or pin-worm, as it is usually called). The other tree showed no congealed sap, and had been very savagely attacked by this fly. To my mind, this indicated that the sap in at least some of the trees of the tropics travelled up and down at least once a month, and while up in the tree, provided, when such tree was felled, the condition of the wood after which the fly-worm sought. I might mention that the removal of the bark from this tree in which the sap was up, and which the fly had so vigorously attacked, disclosed a fermented condition which was not apparent in the other tree. It was evidently this stage of fermentation of the sap in the wood which the fly sought."

The non-observance of any such careful attention both to the broad principles and the details of the conversion and preservation of timber, as is now being recommended, has undoubtedly been the cause of the failure to provide from home supplies the timber required for ordinary purposes, while many of the defects appearing after conversion, both in home and foreign wood, are traceable to this cause.

The methods pursued in this country are vastly inferior to those of the majority of the timber-producing countries. Having now in mind the depleted stocks throughout the world at the present time and the difficulty of transport, coupled with the enormous present and future demand for timber, the subject of its economic use is of the greatest possible importance, and merits the consideration of all those who are engaged in the timber industry.

SPECIFICATIONS AND CONDITIONS OF CONTRACT

The specifications of timber vary according to the purpose for which the architect requires it, but the specifications which are demanded often do not correspond with what is possible to be supplied. On the one hand buyers often demand a wood of better quality than is necessary, and are thereby involved in needless expense, and on the other hand they at times specify a wood which is no longer obtainable. Since timber is a natural product it is subject to considerable variation, and therefore terms of quality cannot be used in an absolute sense. The case is illustrated by an incident which occurred when the supplies of some English oak timber and scantlings were rejected and the timber merchant, after hearing the opinion of the builder, replied, " Yes, I see exactly what you want : I will go and plant some of that sort."

One specification given recently reads : " The whole of the timber for carpentering work to be of the best Memel or Dantzic " ; and another " The whole of the timber to be of the best Memel, Riga or Dantzic fir; joiners, the whole of the timber to be of the best Christiania redwood." Again : " The timber, joists, etc., to be of the best quality pine, not fir, wrongly so-called by timber merchants." These are all supplemented by terms of quality which say that the timber is to be bright, clean, free from sap and loose or dead knots, while in some cases the only phrase used is, " to be free from knots." The terms " fir," " red fir," " yellow deal " or " yellow," and " white deal " or " white," have become general, and are usually understood to describe what should properly be called " red Baltic pine " and " spruce," the produce respectively of *Pinus sylvestris* and *Picea excelsa* (see p. 212). For very many years past the use of Memel, Riga, or Dantzic pine has been limited to that work which requires large-sized baulks or squares, generally hewn as imported, or occasionally rough sawn, but which is always used for heavy timbering in rough work. To use such timber for other construction is quite unnecessary, as the forests of the Baltic in Sweden and Russia have provided sufficient supplies of high-class quality of so-called redwood [pine], imported sawn to all convenient sizes suitable for the lighter forms of timbering, and for joiners' work. More than thirty years ago supplies of fine quality pine were obtainable from Christiania, but the forests of Norway have long since failed to produce timber either large enough or of sufficiently good quality for these requirements. The last shipments were seen nearly forty years ago (1919). Since that time the highest class quality has been produced from Archangel and Petrograd, and from Gefle and Soderham and some other Swedish ports; still later, supplies of high quality have been obtainable from Siberia. With reference to the conditions of quality, none of this timber is actually free from sap or knots, but while it is not desirable that there should be too great a prevalence of these defects, yet for practical purposes some proportion can be safely allowed. In a building more than 200 years old, some Baltic pine joists which, judging from the appearance of the manufacture, were probably Swedish, were fitted into English oak beams; when taken out in 1890, some of the oak had become worm-eaten and decayed, even into the heart-wood, but the sap and heart-wood of the pine were found to be bright, sound, and hard. The sap-wood of some large roof timbers which were known to be Swedish pine, when taken from a sawmill which had been built for over thirty years, was found to be perfectly sound and bright. Thus it will be seen that the sap-wood as well as the heart-wood of the produce of *Pinus sylvestris*, if used in good condition, is durable. The proportion and size of knots, provided that they are sound, should be in ratio to the size of scantling, when they may be safely allowed.

The application of the term "bright" to certain timbers gives rise to undesirable results, for on this account it often happens that fresh timber which has a showy appearance, even if it is entirely unseasoned and fresh from the ship, is tendered and accepted in preference to darker coloured, dingy-looking wood which is seasoned. Indeed, it has sometimes happened that properly seasoned timber has been rejected on account of its appearance. The unseasoned timber subsequently shrinks, and then the ceilings and walls of the building crack, doors do not shut properly, and openings admitting draughts occur between skirting and floor.

Again, it must be noted that requirements vary according to local custom. In the east of Scotland and the north-east of England it has been customary to use spruce (*Picea excelsa*) for timbering, and yellow pine, or, as it is termed there, white pine (*Pinus Strobus*) for joiners' work. On the west coast, spruce has been used for timbering, and red pine (*Pinus resinosa*, Sol.; *P. rubra*, Michx.) for joiners' work. In the south of England, where spruce is universally condemned, red Baltic pine (*Pinus sylvestris*) is usually employed for timbering, and the better grades of the same wood for joiners' work. Therefore, if by chance the work may happen to be ordered in England by a Scottish architect, or in Scotland by an English one, further complications have arisen.

In specifications issued for the use of decorative woods, and for such work as hardwood floorings, the following are some of the kinds which are named:

Best quality Moulmein teak.
Best quality Spanish mahogany.
Best quality Austrian wainscot.
Best quality White Indiana oak.

It may be safely said that in the majority of cases where the above woods are specified, the actual variety named is rarely obtained. Supplies of Moulmein teak have long been falling short. Spanish mahogany is procurable, but it is more defective than other kinds, and more troublesome to obtain, and while it does not cost more per foot, the finished work executed in it would be more expensive, and consequently it is little used (see Mahogany, Spanish). A glance at the total imports of Austrian wainscot will show the impossibility of fulfilling the requirements for this article. Indiana white oak is a term for the northern white oak of America, originally obtained from a comparatively limited area, the centre of which was the State of Ohio. The supplies of this have practically ceased, and have been replaced by oak which might be called almost any shade except white.

In reference to the questions of quality, a practical lesson can be learned from the course adopted in America. In that country timber is classified according to the rules of the National Hardwood Lumber Association. The term "lumber" is used in America to describe all kinds of timber which have been converted by the saw. These rules, which are accepted by all, recognise that some defects are inevitable in timber, and must therefore be accepted in a reasonable and practical manner. The adoption of such a formula enables those concerned to protect their different interests. Under the conditions of the Association, all lumber is divided into what are known as standard grades. These are:

I. Firsts and Seconds.
II. No. 1 common.
III. No. 2 common.
IV. No. 3 common, etc.

Firsts and seconds are combined as one grade. The various faults of timber are specifically named under "Standard defects," and an exact number of such defects is allowed to be included, in proportion to the grading. Thus, bright sap is only considered a defect in such woods as mahogany and walnut, where its appearance mars the effect of the timber, and in such cases a very limited amount is allowed. One knot not exceeding 1½ inches in diameter, or two knots not exceeding in extent one 1¼ inch diameter knot, are considered defects, but in the description of the grading a small percentage of such defects is allowed in the best quality, with admission of a larger number in the lower qualities. These rules and regulations are laid down in a very comprehensive book which is issued by this Association. As both buyer and seller are guided by these rules as translated by the inspectors of the Association, all disputes are easily solved. Although perhaps this system might not exactly suit our needs, some such formula might be agreed upon and brought into general use. The unfortunate results of the present practice with its lack of any system is not only confined to these difficulties already mentioned, but is also the cause of unnecessary expenditure of private and public monies. The cottage which has hard wear and few carpets has a flooring ⅞ inch thick, while the mansion will have a floor of 1¼ inch or 1½ inch thickness which is thickly carpeted. It has often happened that the doors and joiners' work of public buildings such as schools, hospitals, workhouses, prisons and lunatic asylums have been provided at great expense under a stringent specification excluding sap and knots, with similar extravagance in the timbering, when ordinary qualities admitting a full inclusion of reasonable sap and knots would have been as serviceable. Again, it sometimes happens that, instead of accepting trade thicknesses, which are all nominal, *i.e.* planed or worked from the particular thickness asked for, full thickness when finished is demanded. This is a greater extravagance than is at first apparent, as it necessitates very much waste, since a 3-inch plank is often necessary to provide a 2-inch finished thickness. Expensive hardwoods are also often used with all defects ruled out, when substitutes not so costly and admitting reasonable defects would be as serviceable. It is obvious that some system is necessary which would meet the conditions which arise in the United Kingdom.

The question here raised is of vital importance in the timber, engineering, and building trades. This has been recognised by the authorities concerned with aircraft production, and important principles have been laid down which to some extent do regulate timber specifications so far as they concern aircraft. This has been due to the investigations and work of the British Engineering Standards Association. The conclusions so reached need, however, a wider application, and indeed form little more than a starting-point for the co-ordination and regulation of timber specifications for all industries concerned, and for the establishing of a standard scale of specifications which shall be recognised all over the country.

LASLETT'S TABLES

In order that the careful and painstaking experiments made by Thomas Laslett (*Timber and Timber Trees*) on a great variety of woods, a work which was carried out in a conscientious manner over a prolonged period, should not be lost sight of, his tables of tests are here reprinted complete. Much of machinery used by Laslett in determining these results is no longer available, and the circumstances which brought about the necessity of the tests in his time are not likely to re-occur. In the same way, many of the tests made during the European War on timbers used in aircraft construction will possibly not be required again for a number of years. While these tables are not exhaustive, yet their value is great and they form an important addition to our knowledge of the subject, and more frequent reference should be made to them.

Especial care was taken to carry out the experiments upon wood brought to a well-seasoned condition and fit for appropriation to works of construction; and in many instances he tried not only a series of pieces taken from different trees, but a series of pieces from the same tree, with a view to find, if possible, in what part the maximum strength lay.

The tests for the transverse strength were conducted in every case with pieces 2" × 2" × 84" = 336 cubic inches. Each piece was placed upon supports exactly 6 feet apart, and then water was poured gently and gradually into a scale suspended from the middle until the piece broke, note being taken of the deflection with 390 lbs. weight and also at the crisis of breaking.

After this a piece 2 feet 6 inches in length was taken, wherever it was found practicable, from one of the two pieces broken by the transverse strain, and tested for tensile strain by means of a powerful hydraulic machine, the direct cohesion of the fibres being thus obtained with great exactness. Further, for the purpose of determining the proportions of size to length best adapted for supporting heavy weights a great many cube blocks were prepared, of various sizes, as also a number of other pieces of different form and dimensions, which were then, by the aid of the same machine, subjected to gradually increasing vertical pressure in the direction of their fibres, until a force sufficient to crush them was obtained.

In Laslett's time apparatus for determining the moisture contents of wood was not available; but it would certainly be preferable in the future for all experiments to be conducted with some named and specific percentage of moisture. At the present time with the machinery which is obtainable for this purpose, it should be possible for a complete series of experiments to be conducted where the percentage of moisture has been reduced to some standardised level. If such information were available it would prove invaluable.

TABLE I.—ASH (CANADIAN).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking				
	Inches.	Inch.	Inches.	lbs.			lbs
1	2·5	·10	7·00	696	493	847	174
2	3·0	·15	7·75	580	467	745	145
Total .	5·5	·25	14·75	1276	960	1592	319
Average .	2·75	·125	7·375	638	480	796	159·5

TABLE II.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches		lbs	lbs
3	2 × 2 × 30	558	16,240	4,060
4		544	17,360	4,340
5		625	28,560	7,140
6		625	25,760	6,440
Total . .	..	2352	87,920	21,980
Average . .	..	588	21,980	5,495

TABLE III.

Vertical or Crushing Strain on cubes of 2 inches.

No. 7.	No. 8.	No. 9.	No. 10.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
7·25	7·75	12·75	11·50	39·25	9·812	2·453

E = 343980. S = 1675.

TABLE IV.—ASH (ENGLISH).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·75	·05	8·50	879	750	730	219·75
2	1·50	·05	8·75	845	722	702	211·25
Total .	3·25	·10	17·25	1724	1,472	1432	431·00
Average .	1·625	·05	8·625	862	736	716	215·5

TABLE V.

Tensile Experiments.

Number of the specimen.	Dimensions of the piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
3	2 × 2 × 30	750	15,120	3,780

TABLE VI.

Vertical or Crushing Strain on cubes of 2 inches.

No. 4.	No. 5.	No. 6.	No. 7.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
13·00	12·00	12·25	12·5	49·75	12·4375	3·1094

E = 573100. S = 2263.

TABLE VII.—CEDAR (CUBA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·25	·05	4·35	530	372	855	132·50
2	2·35	·30	4·35	555	386	863	138·75
3	2·00	·25	4·25	630	530	713	157·50
4	2·25	·25	4·25	560	504	666	140·00
5	2·25	·35	4·35	550	416	793	137·50
6	2·50	·35	4·65	535	425	755	133·75
Total .	13·60	1·55	26·20	3360	2633	4645	840·00
Average .	2·266	·258	4·366	560	439	774	140·00

REMARKS.—All broke with a short fracture.

TABLE VIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	416	11,760	2,940
8		425	11,200	2,800
9		504	12,320	3,080
10		530	10,640	2,660
Total . .	. .	1875	45,920	11,480
Average . .	. .	469	11,480	2,870

TABLE IX.

Vertical or Crushing Strain on cubes of 2 inches.

No. 11.	No. 12.	No. 13.	No. 14.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
8·00	7·75	9·00	7·25	32·00	8·00	2·00

E = 449710. S = 1470.

TABLE X.—ELM (ENGLISH).

Transverse Experiments.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	Deflections. After the weight was removed.	Deflections. At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 700.	Weight required to break 1 square inch.
	Inches.	Inches.	Inches.	lbs.			lbs.
1	..	..	3·50	..	578	..	..
2	5·25	1·25	7·50	510	571	625	127·5
3	..	..	6·25	..	558	..	..
4	..	..	4·00	..	553	..	..
5	4·75	1·30	5·50	450	545	450	87·5
6	4·70	1·35	5·00	420	542	413	80·0
Total .	14·70	3·90	31·75	1380	3347	1488	295·00
Average .	4·90	1·30	5·291	460	558	496	98·33

TABLE XI.

Tensile Experiments.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	690	21,060	5,040
8		625	26,880	6,720
9		611	18,480	4,620
Total . .	..	1926	66,420	16,380
Average . .	..	642	22,140	5,460

TABLE XII.

Vertical or Crushing Strain on cubes of 2 inches.

No. 10.	No. 11.	No. 12.	No. 13.	No. 14.	No. 15.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
10·125	10·00	10·75	10·50	10·25	10·375	62·00	10·333	2·583

E = 250820. S = 1032.

TABLE XIII.—GREENHEART (DEMERARA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·15	·05	5·00	1235	1180	1047	308·75
2	2·00	·00	4·75	1656	1193	1388	414·00
3	2·25	·15	4·60	1305	1079	1209	326·25
4	2·00	·00	5·00	1212	1152	1052	303·00
5	2·25	·15	4·15	1258	1172	1073	314·50
6	2·25	·05	4·25	1329	1122	1184	332·25
Total .	12·90	·40	27·75	7995	6898	6953	1,998·75
Average .	2·15	·066	4·625	1332·5	1149·6	1158·8	333·125

REMARKS.—Nos. 1, 2, 3, and 6 broke with splintery fractures 12 to 15 inches in length; 4 and 5 with similar fractures, but only 10 to 12 inches in length.

TABLE XIV.

Tensile Experiments.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Weight the piece broke with	Direct cohesion on 1 square inch.
	Inches		lbs.	lbs.
7	2 × 2 × 30	1152	31,920	7,980
8		1079	36,400	9,100
9		1193	37,520	9,380
Total . .	..	3424	105,840	26,460
Average . .	..	1141	35,280	8,820

TABLE XV.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
10–13	7·00	27·000	57·125	93·150
14–17	6·75	27·362	58·000	92·875
18–21	6·75	27·750	57·250	92·625
22–25	6·50	27·000	56·875	93·500
Total . .	27·00	109·112	229·25	372·150
Average . .	6·75	27·278	57·312	93·037
Do. per inch .	6·75	6·819	6·368	5·814

TABLE XVI.—GUM, BLUE (AUSTRALIA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·15	4·50	767	1079	711	191·75
2	1·75	·20	3·75	602	997	604	150·50
3	1·35	·10	5·75	710	1037	684	177·50
4	1·00	·00	3·75	767	1108	692	191·75
5	1·25	·15	3·50	684	1026	666	171·00
6	1·00	·00	4·00	741	924	801	185·25
Total .	7·60	6·0	25·25	4271	6171	4158	1067·75
Average .	1·26	·10	4·21	712	1029	693	177·96

REMARKS.—Each piece broke with a short fracture.

TABLE XVII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	997	14,560	3,640
8		1079	26,600	6,650
9		1037	24,360	6,090
10		1108	26,600	6,650
11		1026	28,840	7,210
Total . .	..	5247	120,960	30,240
Average . .	..	1049	24,192	6,048

TABLE XVIII.

Vertical or Crushing Strain on cubes of 2 inches.

No. 12.	No. 13.	No. 14.	No. 15.	No. 16.	No. 17.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
12·875	13·000	12·750	11·125	10·500	13·625	73·875	12·312	3·078

E = 778300. S = 1869.

TABLE XIX.—HORNBEAM.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
			lbs.	lbs.
1	2 × 2 × 30	808	28,560	7,140
2		815	27,440	6,860
3		815	23,520	5,880
4		836	22,960	5,740
Total . .	..	3274	102,480	25,260
Average . .	..	819	25,620	6,405

TABLE XX.

Vertical or Crushing Strain on cubes of 2 inches.

No. 5.	No. 6.	No. 7.	No. 8.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
14·25	15·00	15·125	15·00	59·375	14·844	3·711

TABLE XXI.—IRON-BARK (AUSTRALIA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	·85	·0	3·75	1460	1163	1255	365·0
2	1·00	·0	3·50	1370	1146	1195	342·5
3	·90	·0	4·00	1400	1142	1226	350·0
4	1·00	·0	4·00	1400	1116	1254	350·0
Total .	3·75	·0	15·25	5630	4567	4930	1407·5
Average	·94	·0	3·812	1407·5	1142	1232	351·9

REMARKS.—No. 1, wiry fracture, 16 inches in length; No. 2, wiry fracture, 12 inches in length; No. 3, wiry fracture, 10 inches in length; No. 4, broke short to one-third depth, then splintery fracture, 10 inches in length.

Table XXII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
5	2 × 2 × 30	1142	34,160	8,540
6		1146	26,880	6,720
7		1163	39,480	9,870
Total . .	..	3451	100,520	25,130
Average . .	..	1150	33,507	8,377

Table XXIII.

Vertical or Crushing Strain on cubes of 2 inches.

No. 8.	No. 9.	No. 10.	No. 11.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
18·500	17·625	18·500	19·000	73·625	18·406	4·601

E=960740. S=3695.

Table XXIV.—Jarrah (Australia).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·85	·10	4·50	743	987	753	185·75
2	3·25	·15	4·50	638	1049	608	159·50
3	3·25	·15	5·00	661	977	677	165·25
4	3·50	·15	5·00	661	1039	636	165·25
5	3·15	·10	4·50	726	1006	722	181·50
6	3·25	·15	4·75	685	1002	684	171·25
Total .	19·25	·80	28·25	4114	6060	4080	1028·50
Average	3·21	·133	4·71	685·66	1010	680	171·416

Remarks.—Each piece broke short.

Table XXV.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	987	10,080	2,520
8		1006	13,440	3,360
Total . .	..	1993	23,520	5,880
Average . .	..	996	11,760	2,940

Table XXVI.

Vertical or Crushing Strain on cubes of 2 inches.

No. 9.	No. 10.	No. 11.	No. 12.	No. 13.	No. 14.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
12·875	13·000	12·625	12·750	12·750	12·750	76·75	12·792	3·198

E = 296810. S = 1800.

Table XXVII.—Kapor or Camphor (Borneo).[1]

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	·75	·08	3·75	1213	910	1333	303·25
2	·60	·00	3·50	1123	965	1149	280·75
3	·75	·05	3·75	1168	1053	1109	292·00
4	·50	·05	4·00	1236	977	1265	309·00
5	·65	·10	4.10	1238	936	1323	309·50
6	·65	·00	3·50	1127	895	1260	281·75
Total .	3·90	·28	22·60	7105	5736	7439	1776·25
Average .	·65	·046	3·766	1184·16	956	1239·83	296·04

Remarks.—All broke with splinters 4 to 8 inches in length.

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[1] **There is little doubt that this test refers to the product of a species of *Dipterocarpus*, which strongly resembles yang.**

TABLE XXVIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7 8	2 × 2 × 30	965 977	25,760 28,560	6,440 7,140
Total . .	..	1942	54,320	13,580
Average . .	..	971	27,160	6,790

TABLE XXIX.

Vertical or Crushing Strain on cubes of 2 inches.

No. 9.	No. 10.	No. 11.	No. 12.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
21·75	21·25	21·00	21·25	85·25	21·31	5·33

E = 1463000. S = 3108.

TABLE XXX.—KARRI (AUSTRALIA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	·75	·00	5·00	820	957	855	205·00
2	1·25	·00	6·25	725	885	819	181·25
3	1·35	·10	4·60	955	1023	934	238·75
4	·75	·05	7·50	840	987	851	210·00
5	1·00	·05	6·50	920	1013	908	230·00
6	1·00	·05	6·50	915	1023	903	228·75
Total .	6·10	·25	36·35	5175	5888	5270	1293·75
Average .	1·01	·04	6·06	862·5	981·33	878·33	215·62

REMARKS.—Each piece broke with scarph-like fracture, 8 to 10 inches in length.

TABLE XXXI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	..	31,080	7,770
8		..	30,800	7,700
9		..	31,360	7,840
10		..	31,360	7,840
11		..	22,120	5,530
12		..	22,960	5,740
Total . .	..	..	169,680	42,420
Average . .	..	981	28,280	7,070

TABLE XXXII.

Vertical or Crushing Strain on cubes of 6 *inches.*

No. 13.	No. 14.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	
175	195	370	185	5·14

E = 930950. S = 2264.

TABLE XXXIII.—KRANJI (BORNEO).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	·75	·05	4·50	1531	1058	1447	382·75
2	·60	·00	4·75	1519	1067	1424	379·75
3	·50	·00	3·25	1382	1051	1315	345·50
4	·75	·00	4·00	1347	956	1409	336·75
5	·65	·05	5·00	1657	1046	1584	414·25
6	·50	·05	2·75	1460	998	1463	365·00
Total .	3·75	·15	24·25	8896	6176	8642	2224·00
Average .	·625	·025	4·04	1482·6	1029·3	1440·3	370·66

REMARKS.—Nos. 1, 5, and 6 broke with very long fracture; 2, 3, and 4 much shorter, and scarph-like.

TABLE XXXIV.—LARCH. (RUSSIAN).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·15	4·5	743	688	648	185·75
2	1·5	·15	5·0	714	697	615	178·50
3	1·5	·00	4·75	708	645	658	177·00
4	1·75	·25	3·85	504	618	489	126·00
5	1·75	·15	4·15	568	647	527	142·00
6	1·65	·35	3·75	519	583	534	129·75
Total .	9·40	1·05	26·00	3756	3878	3471	939·00
Average .	1·566	·175	4·33	626	646·3	578	156·5

REMARKS.—All broke with a moderate length of fracture.

TABLE XXXV.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	618	14,000	3,500
8		645	13,440	3,360
9		647	19,936	4,984
10		688	19,880	4,970
Total . .	..	2598	67,256	16,814
Average . .	..	649	16,814	4,203

TABLE XXXVI.

Vertical Experiments on Cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
11–14	2·875	10·750	19·625	42·75
15–18	2·750	10·875	19·500	42·50
19, 20	2·875	10·750	..	..
21, 22	3·000	10·375	..	..
Total . .	11·5	42·75	39·125	85·25
Average . .	2·875	10·687	19·562	42·62
Do. per inch .	2·875	2·672	2·174	2·663

$E = 649130$. $S = 1643$.

TABLE XXXVII.—LAUAN.

Arc of flexion produced by a constant weight of 2204 lbs. hung from the centre.	Arc at which fracture took place.	Weight applied at centre of the arc.	Distance between the supporters of the wood.
Inch.	Inches.	lbs.	Inches.
0·43	3·15	14·99	23·62 and 26·77

TABLE XXXVIII.

Weight of the specimen.	Resistance			Maximum elasticity to be allowed in construction of buildings.	Weight corresponding to this elasticity.	Strength of elasticity.	Resistance to tortion co-efficient of fracture T.	
	To pressure.		Tension of strength of cohesion.					
	With the grain of the fibre.	On the grain perpendicularly.					Absolute strength.	Applicable strength.
lbs.	lbs.	lbs.	lbs.	Inch.	lbs.	lbs.	lbs.	lbs.
·948	498·24	198·41	1529·99	·038	152·99	158·16	168·43	16·84

REMARKS.—Weight producing fracture at the bend, 1·32 lb. T co-efficient of fracture by bending, or of maximum bend.

TABLE XXXIX.—MAHOGANY (CUBA, OR SPANISH).

Transverse Experiments.

Number of the specimen.	Dimensions.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 700.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·50	·00	3·50	767	720	746	191·75
2	1·50	·00	3·50	883	817	757	220·75
3	1·25	·05	3·50	817	789	725	204·25
4	·85	·00	3·85	956	752	890	239·00
5	1·15	·05	3·35	883	765	809	220·75
6	1·00	·05	3·00	831	771	763	207·75
Total .	7·25	·15	20·70	5137	4614	4690	1284·25
Average .	1·208	·025	3·45	856·16	769	781·66	214·04

REMARKS.—Nos. 1 and 4 broke with moderate length of fracture, and splintery; 3. 5, and 6—each broke very short.

Table XL.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	752	19,040	4,760
8		765	19,824	4,956
9		817	15,120	3,780
10		720	11,200	2,800
11		771	10,640	2,660
Total . .	..	3825	75,824	18,956
Average . .	..	765	15,165	3,791

Table XLI.

Vertical Experiments on cubes of—

Number of the specimens.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
12–15	2·500	12·750	27·250	38·750
16–19	2·750	11·875	27·375	39·150
20–23	2·875	13·625	26·800	38·625
24–27	2·875	13·750	27·425	39·100
Total . .	11·000	52·000	108·85	115·625
Average . .	2·750	13·000	27·212	38·906
Do. per inch .	2·75	3·25	3·024	2·431

Nos. 28 to 36.—Four more pieces—each 2 × 2 × 2 inches—tried under the vertical pressure, took, on the average, 13·937 tons, or 3·484 tons to the square inch, to crush them. Two pieces, each 3 × 3—the one 11 inches, the other 16 inches in length—bore 27 tons and 25·5 tons. Two other pieces, each 4 × 4 inches—the one being 8 inches, the other 13 inches in length—bore respectively 47·75 tons and 38·5 tons; and one piece—12 × 12 × 15 inches in length—bore 481 tons, or 3·34 tons per square inch of base.

$E = 771030$. $S = 2247$.

TABLE XLII.—MAHOGANY (HONDURAS).

Transverse Experiments.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	Deflections. After the weight was removed.	Deflections. At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 700.	Weight required to break 1 square inch.
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·00	·10	4·50	811	644	881	202·75
2	1·75	·00	3·75	821	684	840	205·25
3.	2·25	·10	3·75	750	650	808	187·50
4	2·00	·05	3·55	756	662	799	189·00
5	1·65	·10	4·15	823	650	887	205·75
6	1·85	·15	4·65	851	666	894	212·75
Total .	11·50	·50	24·35	4812	3956	5109	1203·00
Average .	1·916	·083	4·058	802	659·3	851·5	200·5

REMARKS.—Each piece broke with moderate length of fracture, and splintery.

TABLE XLIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	662	10,920	2,730
8		650	12,040	3,010
9		644	9,940	2,485
10		666	14,280	3,570
11		684	12,740	3,185
12		650	12,040	3,010
Total . .	..	3956	71,960	17,990
Average . .	..	659	11,993	2,998

TABLE XLIV.

Vertical or Crushing Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
13–16	2·675	11·00	27·75	45·000
17–20	3·000	11·00	27·00	45·500
21–24	2·675	11·25	26·875	44·875
25–28	2·875	10·75	27·875	45·125
Total . .	11·225	44·00	109·500	180·500
Average . .	2·806	11·00	27·375	45·125
Do. per inch .	2·806	2·75	3·042	2·820

Nos. 29 and 30.

	Crushed with the weight of	
One piece, 9″·5 × 9″·5 × 15″,	307 tons	= 3·493 tons per square inch,
" 9″·5 × 9″·5 × 18″,	336·8 "	= 3·833 " "

E = 492550. S = 2105.

TABLE XLV.—MAHOGANY (MEXICAN).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 700.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·00	3·50	720	790	638	180·00
2	1·25	·10	4·25	700	612	801	175·00
3	1·00	·05	4·25	920	715	901	230·00
4	1·00	·00	3·65	785	665	841	196·25
5	1·25	·15	3·75	880	660	933	220·00
6	1·00	·05	4·15	690	625	733	172·50
Total .	6·75	·35	23·55	4695	4067	4847	1173·75
Average .	1·125	·058	3·925	782·5	677·83	807·83	195·625

REMARKS.—Each piece broke short.

TABLE XLVI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	665	15,680	3,920
8		660	15,120	3,780
9		625	10,640	2,660
10		612	10,304	2,576
11		715	16,800	4,200
Total . . .	..	3277	68,544	17,136
Average . .	..	655	13,709	3,427

TABLE XLVII.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
12–15	2·875	11·500	22·500	38·500
16–19	2·375	9·500	24·000	38·125
20–23	2·250	10·625	22·125	37·500
24–27	2·250	10·500	23·125	39·125
Total . .	9·750	42·125	91·750	153·25
Average . .	2·437	10·531	22·937	38·312
Do. per inch .	2·437	2·633	2·549	2·394

Nos. 28 and 29.

	Inches.		Tons.	Tons.	
One piece,	8·5 × 10 × 12,	crushed with the weight of	279·2 =	3·285	per sq. in.
,,	8·5 × 10 × 21.	,, ,, ,,	245·5 =	2·887	,,

E = 846100. S = 2054.

TABLE XLVIII.—MOLAVÉ (PHILIPPINE ISLANDS).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·10	5·00	1,200	972	1235	300·0
2	1·25	·25	5·75	1,320	987	1337	330·0
3	1·25	·15	4·75	1,210	1080	1120	302·5
Total .	3·75	·50	15·50	3,730	3039	3692	932·5
Average	1·25	·166	5·166	1,243·3	1013	1231	310·83

REMARKS.—Each piece broke with a long scarph-like fracture.

TABLE XLIX.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
4	2 × 2 × 30	987	30,240	7,560
5		972	29,120	7,280
6		1080	34,720	8,680
7		954	20,160	5,040
8		1115	42,000	10,500
Total . .	..	5108	156,240	39,060
Average . .	..	1021·6	31,248	7,812

E = 832990. S = 3264.

TABLE L.—MORA (DEMERARA AND TRINIDAD).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·00	·10	4·75	1353	1075	1258	338·25
2	2·00	·10	5·00	1363	1088	1253	340·75
3	2·15	·15	5·00	1304	1094	1192	326·00
4	2·00	·05	5·00	1284	1090	1178	321·00
Total .	8·15	·40	19·75	5304	4347	4881	1326·00
Average .	2·037	·10	4·94	1326	1086·75	1220·25	331·5

REMARKS.—Each piece broke with about 12 inches length of fracture.

TABLE LI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
5	2 × 2 × 30	1094	37,800	9,450
6		1090	37,240	9,310
7		1075	35,840	8,960
Total . .	..	3259	110,880	27,720
Average . .	..	1086	36,960	9,240

TABLE LII.

Vertical or Crushing Strain on cubes of 2 inches.

No. 8.	No. 9.	No. 10.	No. 11.	No. 12.	No. 13.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
14·875	14·750	14·875	15·750	15·750	15·500	91·50	15·25	3·812

E = 466570. S = 3481.

TABLE LIII.—OAK, AFRICAN.[1]

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·25	·10	5·50	1301	982	1325	325·25
2	2·50	·05	4·25	971	1086	894	242·75
3	2·50	·05	5·75	1231	1008	1221	307·75
4	2·00	·00	5·35	1086	988	1099	271·50
5	1·75	·00	4·75	1014	934	1085	253·50
6	2·50	·10	5·25	1046	962	1087	261·50
Total . .	13·50	·30	30·85	6649	5960	6711	1662·25
Average .	2·25	·05	5·142	1108·16	993·3	1118·5	277·04

REMARKS.—Nos. 1, 3, and 4 broke with a long fracture; 2, 5, and 6, short, but fibrous.

TABLE LIV.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	982	30,800	7,700
8		1008	43,400	10,850
9		934	19,040	4,760
10		962	19,600	4,900
Total . .	..	3886	112,840	28,210
Average . .	..	971·5	28,210	7,052

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[1] Probably *Lophira alata*, Banks.

TABLE LV.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
11–14	5·013	18·625	39·5	64·0
15, 16	4·875	17·875	. .	. .
17, 18	4·875	18·500	. .	. .
19, 20	4·937	18·000	. .	. .
21, 22	4·875	18·500	. .	. .
23, 24	4·875	18·250	. .	. .
Total . .	29·450	109·75	. .	. .
Average .	4·908	18·292	39·5	64·0
Do. per inch .	4·90	4·573	4·388	4·0

TABLE LVI.

Vertical Experiments.

Number of the specimen.	Dimensions of the pieces.		Specific gravity.	Crushed with	Do. on the square inch.
	Inches.	Length. Inches.		Tons.	Tons.
25	2 × 2	1	993	17·000	4·250
26		2		18·292	4·573
27		3		18·875	4·719
28		4		18·125	4·531
29	3 × 3	7	. .	39·500	4·390
30		8	. .	38·500	4·277
31		11	. .	35·500	3·944
32		12	. .	36·000	4·000
33	4 × 4	17	. .	63·000	3·938
34	9 × 10	24	. .	433·200	4·811

E = 410430. S = 2909.

TABLE LVII.—OAK, AMERICAN.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·00	5·00	651	820	794	162·75
2	1·25	·15	7·50	837	695	1200	209·25
3	1·35	·25	8·25	769	738	1042	192·25
4	1·50	·15	7·15	729	736	990	182·25
5	1·85	·25	7·65	627	734	854	156·75
6	1·65	·35	7·25	723	758	967	180·75
Total .	8·85	1·15	42·80	4336	4481	5847	1084·00
Average .	1·475	·191	7·133	722·66	746·83	974·5	180·66

REMARKS.—Nos. 1, 3, and 6 broke quite short; 2, 4, and 5 with a scarph-like fracture, about 8 inches in length.

TABLE LVIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	758	19,600	4,900
8		736	19,052	4,763
9		734	11,748	2,937
10		738	10,920	2,730
Total . .	..	2966	61,320	15,330
Average . .	..	741·5	15,330	3,832

TABLE LIX.

Vertical or Crushing Strain on cubes of 2 inches.

No. 11.	No. 12.	No. 13.	No. 14.	No. 15.	No. 16.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
10·75	10·75	10·5	10·5	10·5	10·125	63·125	10·521	2·630

E = 703230. S = 1897.

TABLE LX.—OAK, AMERICAN WHITE.

Transverse Experiments.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	Deflections. After the weight was removed.	Deflections. At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·65	·15	9·00	836	960	871	209·00
2	1·50	·00	8·50	826	988	836	206·50
3	1·75	·25	9·25	839	950	883	209·75
4	1·75	·10	10·15	882	1010	873	220·50
5	2·35	·35	9·35	744	935	795	186·00
6	2·50	·35	6·75	696	1054	660	174·00
Total .	11·50	1·20	53·00	4823	5897	4918	1205·75
Average	1·916	·208	8·833	803·83	982·8	819·66	200·96

REMARKS.—Nos. 1, 2, 5, and 6 broke with a splintery fracture, 10 to 12 inches in length; 3 and 4, although splintered like the others, were not completely broken asunder.

TABLE LXI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	988	28,004	7,001
8		960	31,076	7,769
9		935	26,600	6,650
10		1010	31,228	7,807
11		950	23,512	5,878
Total . .	..	4843	140,420	35,105
Average . .	..	969	28,084	7,021

TABLE LXII.

Vertical or Crushing Experiments.

Nos.	Dimensions.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Total Tons.	Average Tons.	Ditto on 1 square inch.
12–17	1 × 1 × 1	3·125	3·00	3·125	3·000	3·250	3·500	19·000	3·166	3·166
18–23	2 × 2 × 2	12·000	12·75	12·500	12·125	12·750	12·500	74·625	12·437	3·109
24–27	2 × 2 × 1·2·3·4	9·750	9·06	9·750	10·250	..	..	..	..	..
28	3 × 3 × 3	22·500	..	..	..	..	..	..	22·50	2·50
29	4 × 4 × 4	33·000	..	..	..	..	..	..	33·00	2·06
30	9⅛ × 9⅛ × 15	247·000	..	..	..	..	..	..	247·00	2·97
31	9⅛ × 9⅛ × 24	247·000	..	..	..	..	..	..	247·00	2·97
32	12 × 12¼ × 30	338·000	..	..	..	..	..	..	338·00	2·30

E=528650. S=2110

TABLE LXIII.—OAK, DANTZIC.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	4·30	·15	5·25	474	850	558	118·50
2	4·35	·25	5·25	466	812	573	116·50
3	5·55	·30	6·85	449	817	549	112·25
4	5·75	·25	7·00	456	768	592	114·00
5	5·20	·25	7·85	508	897	566	127·00
6	4·85	·25	6·55	488	872	559	122·00
Total .	30·00	1·45	38·75	2841	5016	3397	710·25
Average	5·00	·24	6·458	473·5	836	566·16	118·37

TABLE LXIV.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	812	13,444	3,361
8		817	14,276	3,569
9		850	17,920	4,480
10		872	21,840	5,460
Total . .	..	3351	67,480	16,870
Average . .	..	838	16,870	4,217

TABLE LXV.

Vertical or Crushing Experiments.

Nos.	Dimensions.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Total tons.	Average tons.	Ditto on 1 square inch.
11–16	1″ × 1″ × 1″	3·575	3·875	3·625	3·750	3·9375	3·875	22·6375	3·7729	3·773
17–22	2″ × 2″ × 2″	13·500	13·250	13·375	13·750	13·8750	13·250	81·0000	13·5000	3·375
23	3″ × 3″ × 3″	28·500	..	..	..	..	..	..	28·5000	3·166
24	4″ × 4″ × 4″	49·000	..	..	..	..	..	..	49·0000	3·062
25–28	2″ × 2″ × 1″2″3″4″	14·125	13·500	14·000	14·250	..	..	55·875	13·9690	3·492

TABLE LXVI.

Experiments on specimens of Dantzic Oak.

Nos. 29, 30, and 31. to ascertain the elongation of the fibres in a length of 3 feet, taken under various strains, the dimensions of the pieces being 2 by 2 by 48 inches.

3 Tons.	4 Tons.	5 Tons.	6 Tons.	7 Tons.	8 Tons.	9 Tons.	10 Tons.	11 Tons.	12 Tons.	13 Tons.	Elongation preceding rupture.	Breaking strain in tons.
Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	Inch.	
1/32	1/16	3/32	2/16	5/32	3/16	7/32	4/16	4/16	..	..	4/16	11·25
1/32	1/16	2/32	2/16	5/32	3/16	7/32	8/16	4/16	4/16	4/16	4/16	13·25
1/32	1/16	2/16	3/16	4/16	..	..	..	..	..	..	4/16	7·50
Mean ·0312	·062	·0937	·146	·187	·218	·25	·25	·25	·25	·25	·25	10·666

E = 189680. S = 1243.

TABLE LXVII.—OAK, ENGLISH.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inch.	lbs.			lbs.
1	3·500	·200	5·250	590	905	652	147·50
2	3·125	·312	8·500	825	682	1209	206·25
3	3·250	·125	11·000	1002	708	1415	250·50
4	3·250	·125	6·500	797	725	1099	199·25
5	3·500	·250	7·000	804	720	1116	201·00
6	3·625	·125	5·875	637	670	936	159·25
Total .	20·250	1·137	44·125	4655	4410	6427	1163·75
Average .	3·375	·189	7·354	776	735	1071	193·96

E = 283410. S = 2037.

REMARKS.—Nos. 1 and 4 broke with a moderate length of fracture; 2, 5, and 6 with 9 to 15 inches and splinters in fracture. No. 3 was not completely broken asunder.

TABLE LXVIII.—OAK, ENGLISH.

Transverse Experiments.—Second Example.

Number of the specimen.	Deflection.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
7	1·625	·125	4·125	674	780	864	168·50
8	1·625	·250	5·250	837	753	1112	209·25
9	1·500	·187	5·000	824	770	1070	206·00
10	1·625	·125	9·500	977	1005	972	244·25
11	1·750	·000	9·250	882	1003	879	220·50
12	1·500	·000	8·750	827	1002	825	206·75
Total .	9·625	·687	41·875	5021	5313	5722	1255·25
Average .	1·604	·114	6·979	837	886	954	209·21

E = 605950. S = 2197.

REMARKS.—No. 7 broke short; 8 and 12 with 7 to 13 inches length of fracture; 9, 10, and 11 with 15 inches scarph-like splintery fracture.

TABLE LXIX.

Transverse Experiments.—Third Example.

	Number of the specimen.	Deflection.		Total weight required to break each piece.	Specific gravity.	Total weight required to break 1 square inch.	Direct cohesion on the square inch.	Number of the specimen in the tree.
		With the apparatus weighing 390 lbs.	At the crisis of breaking.					
The mean of 1′ to 6′	..	Inches. 3·25	Inches. 3·95	lbs. 407	867	lbs. 101·75	lbs.	
ENGLISH OAK.	13	3·75	3·75	390	836	97·5	..	6′
	14	3·75	3·75	400	866	100·0	..	5′
	15	..	3·50	390	868	97·5	..	4′
	16	..	..	390	865	97·5	..	3′
	17	..	3·75	390	860	97·5	..	2′
	18	2·25	5·00	480	910	120·0	..	1′
	19	2·00	7·00	740	900	185·0	5320	1
	20	2·00	4·50	630	900	157·5	4400	2
	21	2·25	5·00	620	854	155·0	4200	3
	22	3·50	4·50	470	864	117·5	4340	4
	23	3·75	5·00	480	838	120·0	2520	5
	24	4·00	4·50	430	791	107·5	2240	6
The mean of 1 to 6 .		2·916	5·10	562	858	140·5	3837	..
The mean of the whole		3·083	4·525	484	862·5	121	..	..

REMARKS. - Nos. 13 to 17 inclusive broke very short; 18 and 19 were nearly alike, and had scarph-shaped fractures 10 inches in length; 20 and 21 had long splintery fractures; 22 to 24 inclusive broke short to ¼th the depth, then long fractures.

TABLE LXX.

DEFLECTIONS: ENGLISH OAK.

Specimens: depth, 1½ inch; breadth, 2 inches; length, 84 inches; weighted with 300 lbs.

Supports, apart.		3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Sp. gr.	Inches.	Inches.	Inches.	Inches.
25	795	·375	·750	1·187	2·500
26	785	·500	·875	1·750	2·750
27	782	·375	·750	1·625	2·500
28	775	·375	·750	1·500	2·625
Total .	3137	1·625	3·125	6·062	10·375
Average	784	·406	·781	1·515	2·593

Table LXXI.

Specimens as in Table LXX., weighted with 400 lbs.

Supports, apart.		3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Sp. gr.	Inches.	Inches.	Inches.	Inches.
29	795	·625	1·00	2·00	3·625
30	785	·687	1·125	2·25	3·937
31	782	·437	1·000	2·25	3·562
32	775	·625	1·000	2·00	3·250
Total . .	3137	2·374	4·125	8·50	14·374
Average .	784	·593	1·031	2·125	3·593

Table LXXII.

Specimens: depth, 2 inches; breadth, 1½ inch; length, 84 inches; weighted with 300 lbs.

Supports, apart.		3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Sp. gr.	Inches.	Inches.	Inches.	Inches.
33	795	·312	·625	1·063	1·625
34	785	·250	·500	·875	1·500
35	782	·187	·563	·937	1·562
36	775	·250	·437	·875	1·562
Total . .	3137	1·000	2·125	3·750	6·249
Average .	784	·25	·531	·937	1·562

Table LXXIII.

Specimens as in Table LXXII., weighted with 400 lbs.

Supports, apart.		3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Sp. gr.	Inches.	Inches.	Inches.	Inches.
37	795	·375	·625	1·250	2·125
38	785	·312	·625	1·125	2·000
39	782	·250	·750	1·187	2·125
40	775	·437	·625	1·312	2·000
Total . .	3137	1·374	2·625	4·874	8·250
Average .	784	·343	·656	1·218	2·062

TABLE LXXIV.

Weighted with 300 lbs.				
Supports, apart.	3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Inches.	Inches.	Inches.	Inches.
41	·125	·375	·625	·875

TABLE LXXV.

Weighted with 400 lbs.				
Supports, apart.	3 Feet.	4 Feet.	5 Feet.	6 Feet.
No.	Inches.	Inches.	Inches.	Inches.
42	·250	·500	·875	1·125

TABLE LXXVI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the pieces broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
43	2 x 2 x 30	1003	35,560	8,890
44		1005	31,360	7,840
45		1002	33,600	8,400
46		905	33,040	8,260
47		720	24,640	6,160
48		725	23,520	5,880
Total . .	..	5360	181,720	45,430
Average . .	..	893	30,287	7,571

TABLE LXXVII.

Cubes of Unseasoned British Oak. Specific gravity, 966.
Vertical or crushing experiments.

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
49–52	2·750	7·000	20·000	33·750
53–56	2·500	8·000	19·375	31·875
57–60	2·000	9·500	20·125	33·125
61–64	2·500	8·500	19·625	32·875
65–68	2·250	8·125	20·500	33·125
69–72	2·375	9·250	20·125	33·500
Total . .	14·375	50·375	119·750	198·250
Average . .	2·396	8·396	19·958	33·041
Do. per in. .	2·396	2·099	2·217	2·064

TABLE LXXVIII.

Cubes of Seasoned British Oak. Specific gravity, 740.
Vertical or crushing experiments.

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
73–76	3·750	13·000	28·750	50·875
77–80	3·500	12·500	29·750	50·125
81–84	3·375	14·375	29·125	49·875
85–88	3·625	14·000	28·500	50·625
89–92	3·500	13·875	29·125	49·875
93–96	3·625	14·125	28·875	51·125
Total . .	21·375	81·875	174·125	302·500
Average . .	3·562	13·646	29·021	50·417
Do. per in. .	3·562	3·411	3·225	3·151

TABLE LXXIX.

Vertical or Crushing Experiments on British Oak, with 4 square inches of base.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
97	2 × 2 × 1	740	13·500	3·375
98	,, ,, 2	,,	13·625	3·406
99	,, ,, 3	,,	13·875	3·469
100	,, ,, 4	,,	14·000	3·500
101	,, ,, 5	,,	15·750	3·937
102	,, ,, 6	,,	14·875	3·719
103	,, ,, 7	,,	14·750	3·687
104	,, ,, 8	,,	14·500	3·625
105	,, ,, 9	,,	15·000	3·750
106	,, ,, 10	,,	slipped	—
107	,, ,, 11	,,	14·750	3·687
108	,, ,, 12	720	13·750	3·437
109	,, ,, 18	,,	11·000	2·750
110	,, ,, 24	,,	10·500	2·625
111	,, ,, 30	734	9·750	2·437

NOTE.—Nos. 97 to 107 (inclusive) were cut from one piece of timber; Nos. 108 to 110 were cut from another; and No. 111 from a third piece.

TABLE LXXX.

Vertical or Crushing Experiments on British Oak, with 9 square inches of base.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
112	3 × 3 × 8	912	15·50	1·722
113	,, ,, 9	981	16·125	1·792
114	,, ,, 10	960	16·00	1·777
115	,, ,, 11	943	16·50	1·833
116	,, ,, 12	928	14·75	1·639
117	,, ,, 13	901	13·50	1·500
118	,, ,, 14	891	14·00	1·555
119	,, ,, 15	883	15·00	1·666
120	,, ,, 16	900	15·00	1·666
121	,, ,, 17	768	23·50	2·611
122	,, ,, 18	789	22·00	2·444

NOTE.—Nos. 112 to 120 (inclusive) were cut from a piece of oak timber that had been four years in store—it was not even then well seasoned; Nos. 121 and 122 were of better seasoned timber.

TABLE LXXXI.

Vertical or Crushing Experiments on British Oak, with 16 square inches of base.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
123	4 × 4 × 15	958	25·50	1·600
124	„ „ 16	972	25·25	1·578
125	„ „ 17	934	27·00	1·687
126	„ „ 18	930	27·50	1·719
127	„ „ 19	932	28·25	1·762
128	„ „ 20	972	28·25	1·762
129	„ „ 21	946	28·00	1·750
130	„ „ 22	932	26·00	1·625
131	„ „ 23	921	23·50	1·470
132	„ „ 24	1003	30·00	1·875

TABLE LXXXII.

Vertical or Crushing Experiments on British Oak with 9 square inches of base.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
133	3 × 3 × 8	696	25·25	2·805
134	„ „ 9	597	21·00	2·333
135	„ „ 10	742	20·25	2·250

NOTE.—These were respectively Nos. 115, 118, and 121 of Table LXXX., shortened and further seasoned.

TABLE LXXXIII.

Vertical or Crushing Experiments on British Oak, with 16 square inches of base.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
136	4 × 4 × 10	713	34·875	2·179
137	„ „ 11	658	33·750	2·110
138	„ „ 12	639	32·000	2·000
139	„ „ 13	665	29·500	1·843
140	„ „ 14	752	31·250	1·953
141	„ „ 15	742	28·500	1·781
142	„ „ 16	688	40·750	2·517

NOTE.—These were respectively Nos. 132, 123, 125, 124, 127, 129, and 130 of Table LXXXI., shortened after the first experiments upon them, and further seasoned before the second trial.

TABLE LXXXIV.

Vertical or Crushing Experiments on British Oak; sundry scantlings.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Crushed with	Do. on the square inch.
	Inches.		Tons.	Tons.
143	3 × 3 × 2	820	32·125	3·569
144	4 × 4 × 2	822	53·125	3·320
145	6 × 6 × 12	864	131·000	3·640
146	,, ,, 18	926	154·000	4·277
147	,, ,, 24	822	122·200	3·394
148	,, ,, 36	888	122·200	3·394
149	9 × 9 × 12	1024	223·600	2·760
150	9′ × 9′ × 15	918	247·800	2·898
151	,, ,, 18	889	244·800	2·860
152	,, ,, 21	883	247·000	2·887
153	9′ × 10′ × 15	904	397·000	4·175
154	10′ × 11 × 18	794	307·000	2·722
155	,, ,, 21	819	327·800	2·907
156	9′ × 10′ × 24	905	307·000	3·239

TABLE LXXXV.—PINE, KAURI (NEW ZEALAND).

Transverse Experiments.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	Inches.	Inch.	Inches.	lbs.			lbs.
1 *d*	1·25	·00	3·75	818	525	934	131·25
2 *c*	1·25	·15	4·25	875	529	992	132·25
3 *b*	1·15	·10	4·20	820	529	930	132·25
4 *a*	1·05	·00	3·75	750	520	865	130·00
5 *a′*	1·15	·10	3·40	760	515	885	128·75
6 *b′*	1·50	·15	4·15	870	562	929	140·50
Total .	7·35	·50	23·50	4893	3180	5535	795·00
Average	1·225	·083	3·916	815·5	530	917	132·50

REMARKS.—These specimens broke with a moderate length of fracture.

E = 790810. S = 2141.

TABLE LXXXVI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7 *d*	2 × 2 × 30	525	16,244	4,061
8 *c*		529	20,440	5,110
9 *b*		529	17,920	4,480
10 *a*		520	18,080	4,520
Total . .	..	2103	72,684	18,171
Average . .	..	526	18,171	4,543

TABLE LXXXVII.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
11–14	3·125	10·75	24·5	45·75
15–18	3·500	10·00	24·5	48·00
19, 20	3·125	10·50	..	..
21, 22	3·000	10·75	..	..
Total . .	12·75	42·00	49·0	93·75
Average . .	3·19	10·50	24·5	46·875
Do. per inch .	3·19	2·625	2·722	2·929

TABLE LXXXVIII.

Transverse Experiments.—Top length.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	Deflections. After the weight was removed.	Deflections. At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.	Tensile Experiments. Direct cohesion on 1 square inch.	Tensile Experiments. Number of the specimen.
	Inches.	Inch.	Inches.	lbs.			lbs.	lbs.	
23 *c′*	1·50	·15	3·50	660	534	741	165·0	..	..
24 *b′*	1·65	·20	3·50	630	560	675	157·5	..	..
25 *a′*	1·60	·00	2·25	490	580	507	122·5	..	..
26 *a*	1·40	·00	3·75	690	595	696	172·5	3412	41
27 *b*	1·50	·15	4·25	660	540	733	165·0	3220	42
28 *c*	1·60	·00	4·75	700	545	771	175·0	2485	43
Total .	9·25	·50	22·0	3830	3354	4123	957·5	..	..
Average .	1·541	·083	3·666	638·3	559	687	159·58	..	..

REMARKS.—These specimens broke with a moderate length of fracture.

E = 636410. S = 1676.

TABLE LXXXIX.

Transverse Experiments.—Mid length.

Number of the specimen.	Deflections. With the apparatus weighing 390 lbs.	Deflections. After the weight was removed.	Deflections. At the crisis of breaking.	Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.	Tensile Experiments. Direct cohesion on 1 square inch.	Tensile Experiments. Number of the specimen.
	Inches.	Inch.	Inches.	lbs.			lbs.	lbs.	
29 *c′*	1·50	·25	4·75	655	498	788	163·75	..	..
30 *b′*	1·65	·25	4·25	680	528	773	170·00	..	..
31 *a′*	1·40	·20	5·00	695	553	754	173·75	..	..
32 *a*	1·25	·15	4·50	740	560	793	185·00	3290	44
33 *b*	1·35	·15	4·25	680	545	749	170·00	3045	45
34 *c*	1·35	·25	4·00	705	556	761	176·25	3045	46
Total .	8·50	1·25	26·75	4155	3240	4618	1038·75	..	..
Average .	1·416	·208	4·458	692·5	540	769	173·125	..	..

REMARKS.—These specimens broke with a moderate length of fracture.

E = 735920. S = 1818.

TABLE XC.

Transverse Experiments.—Butt length.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.	Tensile Experiments.	
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.					Direct cohesion on 1 square inch.	Number of the specimen.
	Inches.	Inch.	Inches.	lbs.			lbs.	lbs.	
35 *c′*	1·50	·15	4·00	760	550	829	190·00	..	..
36 *b′*	1·40	·15	3·75	710	580	734	177·50	..	..
37 *a′*	1·50	·20	4·00	705	560	755	176·25	..	..
38 *a*	1·25	·00	3·75	765	595	771	191·25	3325	47
39 *b*	1·25	·15	3·00	640	580	662	160·00	3080	48
40 *c*	1·35	·10	5·25	810	555	876	202·50	3920	49
Total .	8·25	·75	23·75	4390	3420	4627	1097·50	..	..
Average .	1·375	·125	3·958	731·66	570	771	182·91	..	..

REMARKS.—These specimens broke with a moderate length of fracture.

E = 722360. S = 1922.

The mean of the whole being E = 698240. S = 1805.

TABLE XCI.—PINE, PITCH (AMERICAN).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·15	5·05	1068	651	984	207·00
2	1·25	·15	3·75	902	630	859	225·50
3	1·00	·00	5·00	1145	693	991	286·25
4	1·00	·00	4·65	1005	662	911	251·25
5	1·25	·15	5·15	968	620	937	242·00
6	1·00	·00	5·15	1207	698	1038	301·75
Total .	6·75	·45	28·75	6295	3954	5720	1573·75
Average	1·125	·075	4·791	1049·16	659	953·3	262·29

REMARKS.—All the specimens broke with a short fracture.

E = 859950. S = 2754.

TABLE XCII.

Transverse Experiments.—Second Example.

(Butt to top, inner part of the tree.)

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
7	1·25	·10	9·75	860	932	554	215·00
8	1·25	·00	5·00	1020	764	801	255·00
9	1·25	·00	4·50	990	682	871	247·50
10	1·35	·00	4·25	874	652	804	218·50
11	1·25	·15	4·50	876	632	833	219·00
12	1·4	·00	3·25	715	586	732	178·75
Total .	7·75	·25	31·25	5335	4248	4595	1333·75
Average	1·291	·0416	5·208	889·16	708	766	222·29

REMARKS.—No. 7 fractured but not broken asunder, highly resinous; Nos. 8, 9, 10, and 11 broke a little short; 12 broke with a long splintery fracture.

E=722360. S=2334.

TABLE XCIII.

Transverse Experiments.—Third Example.

(Butt to top, outer part of the tree.)

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
13	1·15	·00	3·75	1035	840	740	258·75
14	1·15	·15	2·75	985	788	725	221·25
15	1·00	·00	5·00	1110	760	876	277·50
16	1·25	·15	3·75	920	655	843	230·00
17	1·25	·00	4·75	925	613	905	231·25
18	1·35	·20	4·75	845	610	831	211·25
Total ..	7·15	·50	24·75	5820	4266	4920	1430·00
Average	1·191	·0833	4·125	970	711	820	238·33

REMARKS.—No. 13 broke short and split; 14, curl in the grain and broke short; 15 and 16 broke short and split; 17 and 18 broke with short fracture.

E=815070. S=2546.

Table XCIV.

Transverse Experiments.—Fourth Example.

(Butt to top, inner part of the tree.)

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
19	1·25	·00	4·50	760	583	782	190·00
20	1·50	·15	5·00	778	550	849	194·50
21	1·25	·00	3·75	752	531	850	188·00
22	1·50	·25	4·75	705	505	837	176·25
23	1·50	·25	4·75	695	501	832	173·75
24	1·50	·10	4·50	710	498	855	177·50
Total .	8·50	·75	27·25	4400	3168	5005	1100·00
Average	1·416	·125	4·541	733·33	528	834	183·33

Remarks.—Specimens all broke with fracture of a few inches in length.

E=701530. S=1925.

Table XCV.

Transverse Experiments.—Fifth Example.

(Butt to top, outer part of the tree.)

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
25	1·50	·10	4·75	805	601	803	201·25
26	1·25	·15	5·00	778	572	816	194·50
27	1·25	·05	4·25	742	533	835	185·50
28	1·50	·15	4·00	725	530	821	181·25
29	1·50	·05	4·00	739	528	839	184·75
30	1·50	·00	3·75	741	518	858	185·25
Total .	8·50	·50	25·75	4530	3282	4972	1132·50
Average .	1·416	·083	4·291	755	547	829	188·75

Remarks.—Specimens all broke with fracture of a few inches in length.

E=677270. S=1982.

TABLE XCVI.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the pieces broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
31	2 × 2 × 30	693	16,800	4,200
32		630	17,640	4,410
33		651	19,320	4,830
34		620	17,920	4,480
35		662	19,600	4,900
36		698	20,720	5,180
Total . .	..	3954	112,000	28,000
Average . .	..	659	18,666	4 666

TABLE XCVII.

Vertical or Crushing Strain on cubes of 2 inches.

No. 37.	No. 38.	No. 39.	No. 40.	No. 41.	No. 42.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
10·875	11·125	11·5	11·625	12·00	12·125	69·25	11·542	2·885

TABLE XCVIII.—PINE, RED (CANADA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·85	·15	4·50	590	536	660	147·5
2	1·75	·15	4·25	572	525	654	143·0
3	1·50	·10	3·25	588	576	612	147·0
4	1·65	·15	5·75	700	578	727	175·0
5	1·50	·10	5·50	724	552	787	181·0
6	1·75	·15	4·50	746	554	808	186·5
Total .	10·00	·80	27·75	3920	3321	4248	980·0
Average .	1·666	·133	4·625	653·33	553·5	708	163·33

REMARKS.—Nos. 1, 2, and 6 broke with a moderate length of fracture; 3, 4, and 5, rather short.

TABLE XCIX.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 x 2 x 30	536	11,200	2,800
8		525	11,200	2,800
9		552	11,200	2,800
10		554	6,832	1,708
11		578	13,300	3,325
12		576	11,200	2,800
Total . .	..	3321	64,932	16,233
Average . .	..	553	10,822	2,705

TABLE C.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
13–16	2·375	8·000	21·875	34·00
17, 18	3·500	8·500	..	..
19, 20	3·250	8·250	..	..
21, 22	3·500	8·750	..	..
23, 24	3·750	8·375	..	..
25, 26	3·500	8·875	..	..
Total . .	19·875	50·75	..	..
Average . .	3·312	8·46	21·875	34·00
Do. per inch .	3·312	2·115	2·431	2·125

NOS. 27 TO 30.—Four pieces, each 2 x 2 inches, and respectively 1, 2, 3, and 4 inches in length, crushed with 9·375, 8·460, 8·250, and 9·50 tons.

E=588900. S=1715.

TABLE CI.—PINE, RED BALTIC.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	2·25	·10	5·15	845	534	949	211·25
2	2·00	·05	4·50	700	478	878	175·00
3	1·25	·00	4·65	970	673	866	242·50
4	1·25	·05	5·25	856	512	1003	214·00
5	1·75	·10	6·15	944	639	886	236·00
6	1·25	·10	5·15	945	656	864	236·25
Total .	9·75	·40	30·85	5260	3492	5446	1,315·00
Average .	1·625	·066	5·142	876·66	582	908	219·16

Nos. 1, 2, and 3 broke with a scarph-like fracture 10 inches in length; 4 and 5 a little longer and more splintery; 6 about 15 inches, and also splintery.

TABLE CII.

Tensile Experiments

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	534	13,664	3,416
8		673	17,920	4,480
9		639	12,880	3,220
10		656	11,200	2,800
11		512	8,960	2,240
Total . .	..	3014	64,624	16,156
Average . .	..	603	12,925	3,231

TABLE CIII.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
12–15	3·625	12·875	27·875	47·875
16, 17	2·625	12·750	..	..
18, 19	3·750	12·500	..	..
20, 21	3·250	13·000	..	..
22, 23	3·250	12·125	..	..
24, 25	2·375	12·875	..	..
Total . .	18·875	76·125	..	..
Average .	3·146	12·687	27·875	47·875
Do. per inch	3·146	3·172	3·097	2·992

TABLE CIV.

Vertical Experiments.

Number of the specimen.	Length in inches.	Size in inches.	Square inches in base.	Weight of the specimen.	Specific gravity.	Crushed with	Ditto on the square inch.
				lbs. oz.		Tons.	Tons.
26	1	2 × 2	4	0 2	756	10·875	2·719
27	2			0 3½	756	12·687	3·172
28	3			0 5	720	11·875	2·969
29	4			0 7	756	13·750	3·437
30	5			0 7¾	669	13·750	3·437
31	6			0 9	648	13·000	3·250
32	7			0 10	617	12·750	3·187
33	8			0 11½	621	12·125	3·031
34	9			0 15	720	12·125	3·031
35	10			0 15¼	669	12·500	3·125
36	11			1 2¼	726	11·625	2·906
37	12			1 5½	774	12·000	3·000
38	18			1 10½	636	11·500	2·875
39	24			2 6	684	10·875	2·719
40	30			2 14	662	10·500	2·625

TABLE CV.

Vertical Experiments.

Number of the specimen.	Length in inches.	Size in inches.	Square inches in base.	Weight of the specimen.		Specific gravity.	Crushed with	Ditto on the square inch.
				lbs.	oz.		Tons.	Tons.
41	8	3 × 3	9	1	15	744	21·750	2·417
42	9			1	15½	672	21·500	2·388
43	10			2	1	634	21·625	2·403
44	11			2	4	629	21·500	2·388
45	12			2	15	752	21·875	2·431
46	13			2	13½	672	15·250	1·694
47	14			3	4	713	20·250	2·250
48	15			3	5	679	21·250	2·361

TABLE CVI.

Vertical Experiments.

Number of the specimen.	Length in inches.	Size in inches.	Square inches in base.	Weight of the specimen.		Specific gravity.	Crushed with	Ditto on the square inch.
				lbs.	oz.		Tons	Tons.
49	15	4 × 4	16	5	0	576	37·500	2·343
50	15			4	5	497	32·000	2·000
51	16			5	9	600	36·250	2·265
52	16			4	10	500	34·500	2·156
53	17			6	4	635	36·500	2·278
54	17			4	14	496	32·250	2·015
55	18			5	4½	507	37·875	2·368
56	18			5	9½	556	33·500	2·093
57	19			5	7	494	33·875	2·118
58	20			5	14	508	34·500	2·156
59	21			6	2	504	28·000	1·750
60	22			6	6	501	33·900	2·118
61	23			6	10	498	37·700	2·356
62	24			6	11	495	34·400	2·150

TABLE CVII.

Vertical Experiments on pieces of various dimensions.

Number of the specimen.	Length in inches.	Size in inches.	Square inches in base.	Weight of the specimen.		Specific gravity.	Crushed with	Ditto on the square inch.
				lbs.	oz.		Tons.	Tons.
63	12	6 × 6	36	8	15	571	132·00	3·640
64	18			15	4	654	153·00	4·277
65	24			17	4½	554	153·00	4·277
66	30			24	4	622	122·20	3·394
67	12	9‴ × 10″	102·37	27	0	608	245·40	2·397
68	15			33	13	608	279·20	2·727
69	15	10″ × 10″	110·25	38	12	648	214·80	1·953
70	18			48	6	673	183·80	1·671
71	18	10′ × 10‴	107·5	39	8	564	254·40	2·292
72	21			45	13	561	279·20	2·600

E = 579190. S = 2301.

TABLE CVIII.—PINE (RIGA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·10	3·00	580	524	664	145·00
2	1·00	·10	3·75	707	584	726	176·75
3	1·50	·10	3·30	498	518	577	124·50
4	1·50	·05	4·50	615	534	691	153·75
5	1·35	·10	3·85	677	570	712	169·25
6	1·15	·10	3·35	523	516	608	130·75
Total .	7·75	·55	21·75	3600	3246	3978	900·00
Average .	1·292	·092	3·625	600	541	663	150·00

☞ REMARKS.—No. 1 broke a little short; 2 and 3 with fractures 9 inches in length; in 4, 5, and 6 the fractures were longer and splintery.

TABLE CIX.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	584	17,920	4,480
8		524	12,320	3,080
9		570	19,600	4,900
10		534	14,980	3,745
Total . .	..	..	64,820	16,205
Average . .	..	..	16,205	4,051

TABLE CX.

Vertical or Crushing Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
11–14	3·250	9·000	16·	34·875
15, 16	3·125	7·875	. .	. .
17, 18	3·500	8·250	. .	. .
19, 20	3·750	8·500	. .	. .
21, 22	3·250	8·750	. .	. .
23, 24	3·000	8·250	. .	. .
Total . .	19·875	50·625	. .	. .
Average . .	3·312	8·437	16·	34·875
Do. per inch .	3·312	2·109	1·77	2·179

TABLE CXI.

Vertical or Crushing Experiments.

Number of the specimen.	Length of the specimen.	Scantling.	Area in square inches.	Weight of the specimen.		Specific gravity.	Crushed with	Ditto on 1 square inch.
	Inches.	Inches.		lbs.	oz.		Tons.	Tons.
25	1			0	1	. .	9·875	2·469
26	2	2 × 2	4	0	2	. .	8·437	2·109
27	3			0	3½	. .	11·500	2·875
28	4			0	4½	. .	9·000	2·250
29	5			0	7	. .	10·500	2·625
30	6			0	8½	. .	11·250	2·812
31	7			0	10	. .	11·125	2·781
32	8			0	10½	. .	11·000	2·750
33	9			0	12	. .	10·000	2·500
34	10			0	15	. .	8·000	2·000
35	11			1	1	. .	9·750	2·437
36	12			1	3	. .	11·125	2·781
37	18			1	6	. .	9·875	2·469
38	24			1	8½	. .	6·875	1·719
39	30			2	5½	. .	7·375	1·844
40	12	9½ × 10½	100	28	1	647	367·80	3·678
41	15			27	7	506	214·70	2·147
42	18			33	0	507	245·40	2·454
43	21			48	3	634	245·40	2·454
44	18	10½ × 10½	110·25	46	6	646	307·00	2·784
45	21			54	11	654	307·00	2·784
46	24			55	4	577	279·20	2·532
47	27	12 × 12	144	85	0	604	378·72	2·630
48	30			92	6	593	396·28	2·752

E = 752420. S = 1575.

TABLE CXII.—PINE, YELLOW (CANADA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 squere inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inches.	Inches.	lbs.			lbs.
1	2·00	1·75	4·50	630	424	891	157·5
2	2·00	1·65	5·00	636	432	882	159·0
3	2·00	1·85	4·50	684	464	884	171·0
4	1·75	1·65	4·50	660	444	892	165·0
5	2·25	2·00	3·75	552	435	761	138·0
6	2·75	2·10	5·75	598	411	873	149·5
Total .	12·75	11·00	28·00	3760	2610	5183	940·0
Average	2·125	1·833	4·66	626·6	435	864	156·66

REMARKS.—Tke whole of these broke with a moderate length of fracture and splintery.

TABLE CXIII.

Transverse Experiments.—Second Example.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.	Tensile Experiments.	
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.					Direct cohesion on 1 square inch.	Number of the specimen.
	Inches.	Inches.	Inches.	lbs.			lbs.	lbs.	
7. 3	1·50	·50	4·25	508	568	537	127·0	2,660	3. 22
8. 2	1·25	·50	4·25	562	600	562	140·5	2,800	2. 23
9. 1	1·50	·50	2·25	480	537	536	120·0	2,485	1. 24
10. ⊙	2·25	1·10	2·75	360	430	502	90·0	..	⊙
11. 1′	1·85	·85	3·00	480	588	490	120·0	2,730	1′. 25
12. 2′	1·90	·90	4·25	512	568	541	128·0	2,800	2′. 26
13. 3′	1·75	·65	3·00	478	566	507	119·5	3,080	3′. 27
Total .	12·00	5·00	23·75	3380	3857	3657	845·00	16,555	..
Average .	1·714	·714	3·393	482·85	551	525	120·71	2,759	..

TABLE CXIV.

Transverse Experiments.—Third Example.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.	Tensile Experiments.	
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.					Direct cohesion on 1 square inch.	Number of the specimen.
	Inches.	Inches.	Inches.	lbs.			lbs.	lbs	
14. 4	2·00	·65	3·00	504	562	538	126·00	2,485	4. 28
15. 3	1·75	·65	3·50	556	564	591	139·00	2,800	3. 29
16. 2	1·50	·50	4·75	665	530	753	166·25	2,870	2. 30
17. 1	2·25	·85	4·50	498	560	533	124·50	2,240	1. 31
18. 1′	2·25	·75	3·25	513	526	585	128·25	1,610	1′. 32
19. 2′	2·25	·85	2·75	419	566	444	104·75	2,150	2′. 33
20. 3′	2·50	·75	2·85	421	544	464	105·25	2,100	3′. 34
21. 4′	2·25	·65	3·00	460	564	490	115·00	1,820	4′. 35
Total .	16·75	5·65	27·60	4036	4416	4398	1009·00	18,075	..
Average	2·093	·706	3·45	504·5	552	549·75	126·125	2,259·37	..

E = 650960. S = 1324.

TABLE CXV.

Tensile Experiments.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
36	2 × 2 × 30	464	7,280	1820
37		444	7,840	1960
38		506	9,205	2301
Total . .	..	1414	24,325	6081
Average . .	..	471	8,108	2027

TABLE CXVI.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
39–42	3·625	6·750	15·75	22·875
43, 44	3·000	6·875	..	..
45, 46	2·125	7·250	..	..
47, 48	2·250	8·000	..	..
49, 50	1·875	8·000	..	..
51, 52	2·250	7·750	..	..
Total . .	15·125	44·625	..	..
Average . .	2·521	7·437	15·75	22·875
Do. per inch .	2·521	1·859	1·75	1·430

Vertical Experiments.—Four pieces, Nos. 53, 54, 55, *and* 56, *each* 2 × 2 *inches, and respectively*

	1	2	3	4	Inches in length.
Crushed with	8·5	7·454	8·25	7·875	Tons.

TABLE CXVII.—PYINKADO (BURMA).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	·75	·00	4·50	1240	1150	1078	310
2	1·00	·05	4·60	1250	1225	1020	312·5
3	1·00	·05	4·90	1490	1150	1291	372·5
4	·85	·00	3·25	1110	1165	953	277·5
5	·90	·00	3·50	1130	1225	922	282·5
6	1·25	·10	4·75	1420	1143	1242	355
Total .	5·75	·20	25·5	7640	7058	6506	1910
Average .	·958	·033	4·25	1273·3	1176·33	1084·3	318·33

REMARKS.—Nos. 1, 2, 3, and 6 broke with about 12 inches length of fracture, 4 and 5 with somewhat less. All were fibrous and wiry.

TABLE CXVIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	1143	35,840	8,960
8		1150	41,440	10,360
9		1150	40,320	10,080
10		1225	38,640	9,660
11		1165	38,080	9,520
12		1225	37,420	9,355
Total . .	..	7058	231,740	57,935
Average. .	..	1176	38,623	9,656

TABLE CXIX.

Vertical or Crushing Strain on cubes of 2 inches.

No. 13.	No. 14.	No. 15.	No. 16.	No. 17.	No. 18.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
20·750	20·625	20·875	20·500	21·250	21·000	125·000	20·833	5·208

E = 1,031940. S = 3342.

TABLE CXX.—SABICU.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·00	·00	3·25	1090	936	1165	272·50
2	1·00	·10	4·10	1510	928	1735	377·50
3	1·00	·05	3·15	1090	899	1213	272·50
4	·85	·00	4·25	1390	910	1527	347·50
5	1·00	·05	3·50	1280	923	1387	320·00
6	·90	·00	4·25	1395	904	1543	348·75
Total .	5·75	·20	22·50	7755	5500	8570	1938·75
Average .	·958	·033	3·75	1292·5	916·66	1428·33	323·125

REMARKS.—Nos. 1, 4, 5, and 6 broke with about 10 to 11 inches fracture; 2 and 3 broke with 8 inches fracture.

TABLE CXXI.

Tensile Experiments.

Number of the specimen.	Dimensions of the pieces.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	923	17,360	4,340
8		904	24,360	6,090
9		910	22,120	5,530
10		936	21,280	5,320
11		899	20,776	5 194
12		928	27,496	6,874
Total . .	..	5500	133,392	33,348
Average . .	..	916·66	22,232	5,558

TABLE CXXII.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
13–16	3·000	15·875	36·625	61·75
17, 20	3·250	16·750	36·500	63·75
21, 22	3·125	16·000	..	..
23, 24	2·875	14·750	..	..
Total . .	12·25	63·375	73·125	125·50
Average .	3·062	15·844	36·562	62·75
Do. per inch .	3·062	3·961	4·06	3·922

E = 972320. S = 3393.

TABLE CXXIII.—SPRUCE (CANADA).

Transverse Experiments.

Number of the Specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 600.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·06	6·25	696	451	926	112·75
2	1·20	·05	5·00	719	485	890	121·25
3	1·15	·04	3·75	556	510	654	127·50
4	1·30	·07	5·75	709	490	867	122·50
Total . .	4·90	·22	20·75	2680	1936	3337	484·00
Average .	1·225	·055	5·187	670	484	834	121·00

REMARKS.—No. 1 broke with about 12 inches length of fracture; 2, 3, and 4 with only a little less.

TABLE CXXIV.

Tensile Experiments.

(Dimensions of each piece, 2 × 2 × 30 inches; sp. gr. 484.)

—	No. 5.	No. 6.	No. 7.	No. 8.	Total.	Average.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Weight the piece broke with	13,104	19,040	13,440	17,360	62,944	15,736
Direct cohesion on 1 square inch	3,276	4,760	3,360	4,340	15,736	3,934

TABLE CXXV.

Vertical or Crushing Strain on cubes of 2 inches.

No. 9.	No. 10.	No. 11.	No. 12.	No. 13.	No. 14.	Total.	Average.	Ditto on 1 square inch.
Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
9·00	8·875	7·75	8·875	8·75	8·75	52·00	8·666	2·166

E = 771800. S = 1759.

TABLE CXXVI.—TEAK (BURMA).—No. 1.

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
7	2·05	·25	5·50	840	712	1179	210·00
8	1·35	·10	4·50	971	787	1233	242·75
9	1·75	·15	4·75	867	840	1032	216·75
10	1·65	·00	5·00	915	724	1277	228·75
11	1·75	·00	7·50	923	720	1282	230·75
12	1·35	·00	5·00	960	874	1098	240·00
Total .	9·90	·50	32·25	5476	4657	7101	1369·00
Average .	1·65	·083	5·375	912·66	776·16	1183·5	228·16

E = 576220. S = 2394.

REMARKS.—Each piece broke short to the depth of about one-third, then with scarph-like fracture, 8 to 12 inches in length.

TABLE CXXVII.—No. 2

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
13	1·25	·0	5·25	950	910	1044	237·5
14	2·10	·0	7·00	850	821	1035	212·5
15	1·75	·0	7·00	920	805	1018	230·0
16	1·90	·0	6·75	816	790	1033	204·0
17	1·50	·0	6·50	920	800	1150	230·0
18	3·15	·5	6·25	602	726	829	150·5
Total .	11·65	·5	38·75	5058	4852	6109	1264·5
Average .	1·942	·083	6·485	843	808·66	1018·16	210·75

E = 485720. S = 2213.

REMARKS.—Each piece broke short to the depth of about one-fifth, then with scarph-like and fibrous fracture, 10 to 14 inches in length.

TABLE CXXVIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch
	Inches.		lbs.	lbs.
19	2 × 2 × 30	787	14,564	3,641
20		800	16,240	4,060
21		724	10,916	2,729
22		805	14,000	3,500
23		726	10,368	2,592
24		821	13,152	3,288
Total . .	..	4663	79,240	19,810
Average . .	..	777	13,207	3,301

TABLE CXXIX.

Vertical Experiments on cubes of—

Number of the specimens.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
25–28	2·375	12·500	23·75	37·5
29, 30	2·500	12·500	..	..
31, 32	2·625	10·750	..	..
33, 34	2·500	10·500	..	..
35, 36	2·125	10·750	..	..
37, 38	2·375	11·125	..	..
Total . .	14·500	68·125	..	..
Average .	2·4166	11·354	23·75	37·5
Do. per inch .	2·4166	2·838	2·64	2·343

TABLE CXXX.

Vertical Experiments

Number of the specimen.	Dimensions of the pieces.		Specific gravity.	Crushed with	Ditto on the square inch.
	Inches.	Length. Inches.		Tons.	Tons.
39	2 × 2	1	760	13·750	3·437
40		2	730	11·354	2·838
41		3	770	12·875	3·219
42		4	780	13·750	3·437
43	3 × 3	8	744	18·000	2·000
44		9	704	18·500	2·055
45		10	653	18·000	2·000
46		11	663	18·250	2·028
47		12	640	19·000	2·111
48		13	635	20·000	2·222
49		14	672	23·500	2·388
50		15	678	23·750	2·639
51		16	672	24·250	2·694
52		17	678	24·000	2·666
53		18	661	22·500	2·500
54	4 × 4	15	662	33·5	2·094
55		16	682	34·0	2·125
56		17	724	38·25	2·387
57		18	744	40·25	2·515
58		19	699	37·00	2·312
59		20	756	42·00	2·625
60		21	761	40·25	2·515
61		22	771	37·00	2·312
62		23	690	37·50	2·343
63		24	644	30·00	1·875
64	6 × 6	12	811	153·0	4·250
65		15	831	163·8	4·550
66		18	831	174·0	4·833
67		21	786	169·0	4·694
68		24	836	122·2	3·399
69		27	693	168·4	4·666
70		30	781	153·0	4·250
71	9′ × 9	12	889	307·0	3·776
72	9′ × 9′	15	845	337·8	3·974
73	9 × 9	18	846	286·0	3·530
74	9′ × 9′	18	864	307·0	3·612
75	9′ × 9′	21	828	368·6	4·572
76	9 × 9	24	757	276·2	3·410
77	9 × 9	30	835	307·0	3·790

The mean of Tables CXXIX. and CXXX. = E = 530970. S = 2303.

TABLE CXXXI.

Experiments on Specimens of Teak, to ascertain the elongation of the fibres in a length of 3 feet, under various strains, the dimensions of each piece being 2 × 2 × 48 inches.

Number of the specimen.	2 Tons.	3 Tons.	4 Tons.	5 Tons.	6 Tons.	7 Tons.	8 Tons.	9 Tons.	10 Tons.	Elongation preceding rupture.	Breaking strain.
										Inch.	Tons.
78	1/32	1/16	2/32	2/16	5/32	3/16	..	..	—	3/36	7·75
79	1/32	1/16	3/32	3/32	2/16	3/16	3/16	4/16	5/16	5/16	10·25
80	..	1/32	1/16	2/16	3/16	..	..	..	..	3/16	7·00
The mean.	·0313	·0521	·0729	·1145	·1249	·187	·187	·25	·312	·229	8·333

TABLE CXXXII.—TUART (AUSTRALIAN).

Transverse Experiments.

Number of the specimen.	Deflections.			Total weight required to break each piece.	Specific gravity.	Weight reduced to specific gravity 1000.	Weight required to break 1 square inch.
	With the apparatus weighing 390 lbs.	After the weight was removed.	At the crisis of breaking.				
	Inches.	Inch.	Inches.	lbs.			lbs.
1	1·25	·15	4·50	1071	1147	942	267·75
2	1·25	·00	4·50	972	1173	829	243·00
3	1·15	·20	5·00	1032	1184	872	258·00
4	1·25	·15	5·00	1116	1147	973	279·00
5	1·35	·05	4·85	1017	1170	869	254·25
6	1·35	·10	4·65	966	1194	809	241·50
Total .	7·60	·65	28·50	6174	7015	5294	1543·50
Average .	1·27	·108	4·75	1029	1169·16	882·33	257·25

REMARKS.—Each piece broke with moderate length of fracture, and very fibrous.

TABLE CXXXIII.

Tensile Experiments.

Number of the specimen.	Dimensions of each piece.	Specific gravity.	Weight the piece broke with.	Direct cohesion on 1 square inch.
	Inches.		lbs.	lbs.
7	2 × 2 × 30	1147	32,580	8,820
8		1184	44,520	11,130
9		1173	46,900	11,725
10		1170	34,160	8,540
11		1147	34,720	8,680
12		1194	51,240	12,810
Total . .	..	7015	244,120	61,705
Average . .	..	1169	40,687	10,284

TABLE CXXXIV.

Vertical Experiments on cubes of—

Number of the specimen.	1 Inch.	2 Inches.	3 Inches.	4 Inches.
	Crushed with	Crushed with	Crushed with	Crushed with
	Tons.	Tons.	Tons.	Tons.
13–16	4·000	16·875	37·625	67·00
17–20	4·500	16·750	33·125	64·25
21, 22	4·625	16·500	. .	. .
23, 24	4·750	17·000	. .	. .
Total . .	17·875	67·125	70·75	131·25
Average .	4·469	16·781	35·375	65·625
Do. per inch .	4·469	4·195	3·931	4·102

E=776990. S=2701.

The tables given by Laslett of tests on Spanish, Sardinian, Italian, French, and Dutch oaks respectively, as also on chow and pingow, are not here included, as these woods are no longer of commercial importance.

THE ARTIFICIAL SEASONING OF TIMBER

INTRODUCTION BY A. L. HOWARD AND S. FITZGERALD

THERE has been up to the present in this country a prejudice, unjustified by facts, against adopting or even considering the process of the artificial seasoning of timber, although it is known that in other countries such a process has been in use with evident success. There have been certain definite reasons for this lack of interest in the subject, but at the present, research, somewhat inadequate though it has been so far, has yet supplied sufficient fresh data to justify a readiness to reconsider the value of artificial seasoning.

Before the war Great Britain imported almost the whole of the timber she required, and as the supply was practically unlimited and the shipping unhampered, it was possible to accumulate large stocks of seasoned, partially seasoned, and green timber in this country, and to use these as they came to the required degree of dryness by natural means. The stocks were constantly being renewed, and the disadvantage of having the necessary capital locked up was counterbalanced by the fact that there was no need for the machinery and the technical staff for the seasoning process. Apart from this, it must not be forgotten that timber is an article that must be obtained when it is possible to procure it. Whatever may be the source of supply, the same carefully planned arrangements must be perfected to get the logs to the mill and thence to the shipping port. Once these arrangements are disturbed, it may be long before they can again be set in motion. Thus it may be said that the regularity of timber supplies is always uncertain, and that the large user must therefore secure his stocks when he can.

From time to time trial has been made of artificial seasoning, but more often by the users of timber than by importers and suppliers. Suppliers have attempted it, though solely with the object of rendering the timber sufficiently dry for shipment, but success has been very limited. Those who have adopted the process have not had sufficient faith in its value to give due attention to the quality and effectiveness of the work. Further, there was no incentive to experimental research. On the one hand, suppliers of the drying plant were commercial firms who, when they had accomplished, as the American contracts state, "shipment in sixty days," went no further; while, on the other hand, users of timber were satisfied if they had successfully dried the several kinds and sizes of timber used in their particular manufacture. As a general rule, however, artificial seasoning was only employed as an emergency measure, or because it was impossible to procure naturally seasoned wood.

One of the greatest hindrances to development was the fact that artificially seasoned timber was not *knowingly* accepted for Government contracts, and rarely for private ones. The word "knowingly" is used advisedly, because enormous quantities of imported timber which had undergone the process in other countries were accepted, but the contractor was not permitted to use timber which had been artificially seasoned on his own premises. The use of primitive and harmful processes by people who for various reasons found themselves unable to accept the latest, and perhaps somewhat expensive plant, produced some bad results. Again, where better methods were employed, their operation was too irregular to be efficient, and the results were not encouraging. Thus artificial seasoning has been condemned by those who knew of its frequent failure, but who did not know that such failure was the fault, not of the process itself, but of its indifferent application. All engineering materials except timber lend themselves to rigid tests and graduations. So great, however, are the variations in the grades of timber, that it has hitherto been considered impossible to find any satisfactory series of tests for regular application. Timber is a natural product, and not a manufactured article. A piece produced by one tree or of one species may differ considerably in quality and strength from a piece of a similar species growing within a few yards. Indeed this may vary greatly in different portions of the same tree. Nevertheless, scientific tests can be used with advantage in grading timber even if less strictly than in the grading of steel, for instance. It is found that the facts and figures obtained show regular and consistent results, while an examination of the material thus accumulated proves the advantage of such tests. It becomes clear that it is possible and of much value to calculate the resistance under stress in the case of timber, upon the same principles as it is calculated in the case of other structural materials. It is only necessary to make allowance for wider variations. This margin of variation can, however, be materially reduced through artificial seasoning, which makes possible a more careful and reliable grading. What is yet needed is a series of comparative experiments which shall test wood naturally seasoned and wood artificially seasoned, so that the results of the two processes may be compared and some conclusive facts obtained.

During the period of the war, conditions altered materially. On account of the shortage of shipping space for timber, all existing stocks of seasoned and partly seasoned wood were drawn upon without replacement, and thus a time arrived when the timbers most needed, namely, those used for munitions and aircraft, were practically unobtainable in a seasoned state. The continued prejudice against artificial seasoning, and the lack of official sanction of it, caused enormous quantities of finished parts to be made up of unseasoned timber. These were naturally unsatisfactory, and were either rejected on inspection or, in cases where shrinkage did not develop until later, further damage to material and even danger to life occurred.

The question was finally taken in hand, and the War Office issued a permit for artificial seasoning under certain specified conditions, namely:

1. That the particular process be approved.
2. That the drying be carried out under supervision.

As the situation with regard to aircraft timber was most serious and production was being affected, the Air Board took immediate advantage of this concession and established the necessary technical organisation for testing the results from the various systems of timber drying, together with the staff for supervising the approved plant. A census was made of all existing timber dryers of all types in the country, and those most suitable for aircraft timbers were taken over. A large Compartment Sturtevant Dryer belonging to Messrs. W. W. Howard Brothers & Co. at Poplar was used for establishing data, and also as a training school for kiln supervisors and operators. An Erith progressive dryer was then taken to ascertain the results obtainable with that method. Instruments for keeping autographic records of temperature and humidity were installed in all the dryers in order to keep an exact record of the conditions undergone by each separate charge of timber, and these were kept, together with the tests made on the timber both before and after drying. Having ascertained the exact conditions of time, temperature, and humidity necessary for various kinds and thicknesses of wood, and having trained men to operate the various dryers, a process was arranged which secured homogeneity of result for all timbers used in aircraft manufacture. It is noteworthy that far from any concession as to strength and elasticity being required for timber artificially seasoned under proper conditions, the standards set for naturally seasoned wood were passed, and in most cases with a considerable margin.

It is clear, therefore, that artificially seasoned timber has been used with success in a manufacture which subjects it to the most severe tests, viz. the manufacture of aircraft, but it is important to recognise that the process, to be successful, must be scientifically carried out in properly equipped dryers by trained men.

At the present time the situation is definitely changed. Excellent results have been consistently obtained with enormous quantities of the most difficult timbers, and failure to obtain good results must henceforth be attributed either to an unsatisfactory method or to the inefficiency of the operator.

Home-grown timber is being more largely used at present owing to the shortage of imported stock, and this will probably be extended when the effects of the new afforestation schemes are felt. On this account the need for timber dryers will become urgent if bad or unstable work is to be avoided, for when the timber has left the saw-mills it will be used by the builder whether seasoned or not. If the timber is artificially seasoned direct from the saw, the cost of stacking in the dryer merely corresponds to that of yard stacking, and is therefore not an extra expense. The waste from the mill is used to generate the steam for heating the dryer. This reduces the cost of drying to a minimum. Home-grown hardwoods, such as ash, beech, and oak, can be partly dried at the saw-mill, and the seasoning completed at the user's works after cutting to gross finished sizes. Generally, however, large users will find it advantageous to have their own dryers and to buy their timber green.

In timber-producing countries such as America, Sweden, and Finland, it is the general practice to pass all the planks from the saw through the drying kiln. In America the timber is dried out completely. So treated it is perhaps quite suitable for the very dry climate of that country, but American kiln-dried timber is generally considered "over-dry" in Great Britain. In Scandinavia, on the other hand, the drying is only partial, and is done to reduce the moisture so that the timber can be close piled for shipping, the shipping weight and cost being thereby reduced. Such timber is not ready for immediate use, but requires either air drying for some months or processing in a dryer for about a week.

One of us (S. F.) had experience with some very large timber dryers in Finland, the size of which may be gauged from the fact that when working on 1½-inch thick yellow deal the output of one plant was 60 standards per day, that is, 9900 feet cube. These dryers were put in to fulfil the following specification:

1. To reduce the weight of the wet timber by 30 per cent without warping or splitting.
2. To turn out the dry timber without discoloration, so that it could be sold in England and elsewhere as "Guaranteed NOT kiln-dried."

These conditions were fulfilled in all points, and doubtless many of the opponents of artificial seasoning have used quantities of this "guaranteed not kiln-dried" wood with great satisfaction.

This partial drying is in many ways better than the American drying-out system. It is true that timber which has been over-dried, either artificially or in a very dry climate, will take up moisture if allowed to remain in a damp atmosphere. Such re-moistened timber will have most of the attributes of timber that has not been reduced beyond the dryness natural to the moister climate. The " life " or elasticity and brittleness is, however, in many cases impaired, and if the timber is being used for structural or engineering purposes, over-drying should be avoided.

Partial drying at the saw-mill allows for acclimatisation by natural air-drying at the user's works for about six months, or one or two weeks in the user's dryer, so that the material can be brought to the exact state of dryness most suitable for the work in hand.

To summarise: Relatively little artificial seasoning has formerly been effected in Great Britain, owing to general prejudice and the lack of urgent necessity. Impelling national need during the war caused the process to be then taken up scientifically, and the timber so treated was found to pass the most stringent tests. In the future, those timber merchants and timber users who continue to ignore this factor will be at a great disadvantage in the commercial field compared with those who in a vigorous and enlightened spirit embrace the most modern methods of seasoning their timber ; while it must be remembered that competition will not be confined to this country, but will also include the progressive continental peoples.

THE ARTIFICIAL SEASONING OF TIMBER

By S. Fitzgerald

A History of Timber Dryers

Timber which is cut into planks, and then stacked in the open for a period in such a manner that the air has free access to the surface, is said to be naturally seasoned. By this process the timber takes from six months to four years to dry, and during this period it experiences all the variations of the climate: varying aeration according to the winds, varying temperatures in the different seasons, and varying humidity according to the amount of rain and mist. The actual evaporation of moisture from the wood is effected by the operation of these climatic conditions, namely, aeration and heat, while the process is restrained and over-drying and hardening of the surface prevented by the third factor, namely, the humidity. With the operation of aeration and warmth alone the timber would be dried, but spoilt., With warmth and humidity without aeration the timber might be dried, but its value would be much lessened by fungus and mould.

The seasonal changes of the year bring into play all these conditions, but not in combinations which can be controlled. If it were possible to have continuous March winds, and then gradually supply August heat restrained by November humidity and eliminate the diurnal irregularity of night, timber would season much more rapidly.

It is, therefore, the function of the process of artificial seasoning to produce and maintain by mechanical means the best drying conditions of aeration and temperature, combined with the restraining influence of humidity. It will be well here to submit some definition of an artificial seasoning process. Timber placed in a room where there is an air circulation will not dry without the further condition of heat. If the room is merely heated, the material will naturally dry, but will split and warp. Thus a room heated and ventilated does not supply all that is necessary for a proper process. Many such rooms exist and are wrongly termed "drying-kilns." These can be used for completing the seasoning of boards that are already nearly dry, but they are entirely unsuitable for the rapid seasoning of fresh timber. A proper artificial seasoning process is one in which ventilation, heat and humidity operate in due proportion under proper control.

The idea of rapidly bringing timber into a usable condition by mechanical means, apart from keeping it in a covered or warm place, is modern. The "Smoke Kiln" appears to have been the first attempt to treat timber with heat restrained by moisture. These were used in France seventy to a hundred years ago, and a few have been put up in this country.

A smoke kiln consists of an upper chamber, in the floor of which are holes communicating with the space below. Chimneys or outlets are also provided for the escape of the used air and smoke. In the lower part is a furnace, above which a water tank is generally placed. The heat of the furnace causes the water in the tank to evaporate, and the vapour, together with the hot air and fume from the fire, passes through the perforated floor, circulates round the timber which is stacked in the upper chamber, and finally escapes through the chimney outlets. It was considered advantageous to burn green branchwood from the same species of timber as that which was being dried; it was claimed that the smoke from this toughened the timber under process. The impregnation of timber with solids, liquids, or gases, comes under the heading of timber preservatives, the merits of which are not discussed here. This smoke-kiln process, while it contains the elements required for drying timber, that is, ventilation, heat, and moisture, cannot be strictly regulated to follow a predetermined course, and although on a small scale good results have been obtained, this type of dryer has not proved of real commercial value. Also, in a large kiln it would be impossible to guard sufficiently against the danger of fire.

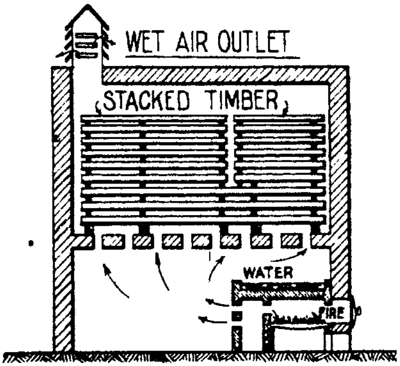
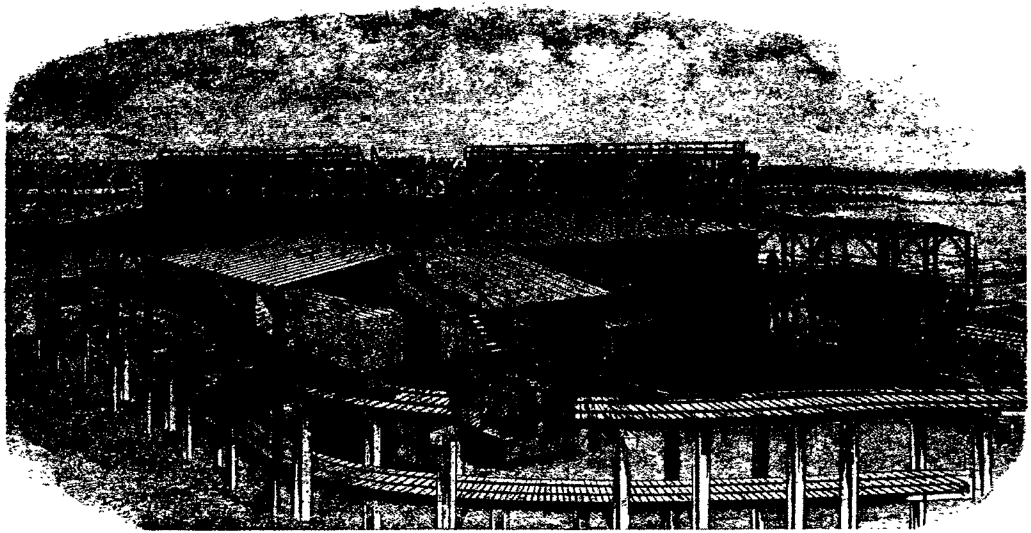


Diagram of Smoke Kiln
Ventilation by Chimney
Heat from Fire
Moisture from Wet Fuel & Evaporation from Tank

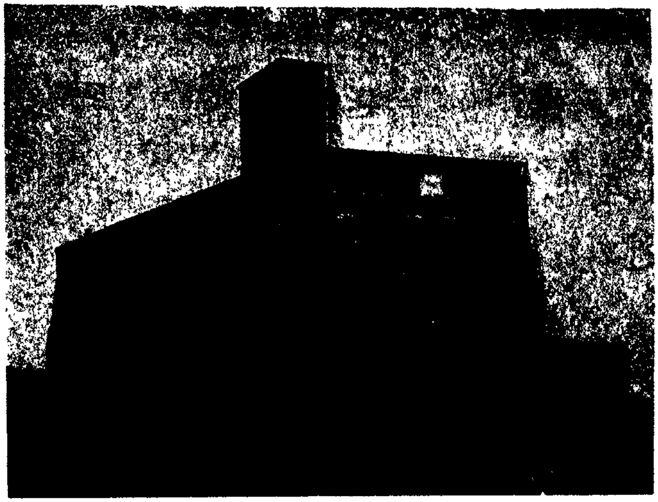
The first development of timber dryers on a large scale was by B. F. Sturtevant in America, who invented the progressive kiln, in order to deal with enormous quantities of soft woods, of one or two thicknesses. He erected large dryers, and developed accessories, such as kiln trucks and transfer systems, which are standard to the present day.

The illustration from B. F. Sturtevant's catalogue of 1890 shows a two-decker kiln which was put up, and which had an output of 125,000 board feet per day (p. 392).



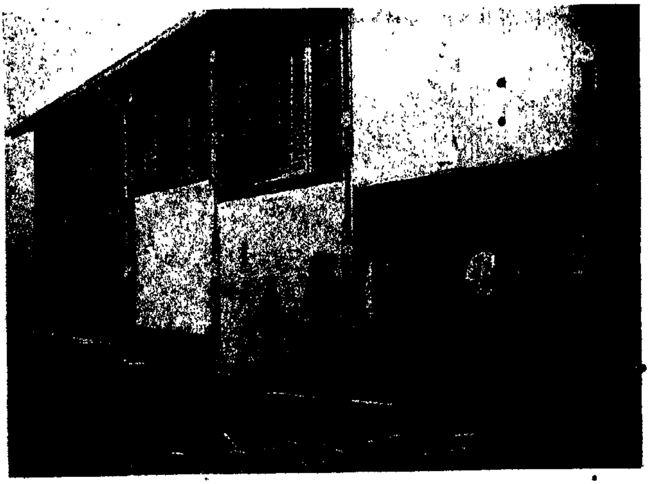
Two-decker Progressive Kiln, built by B. F. Sturtevant thirty years ago.
Capacity 125,000 board feet per day.

(Illustration lent by the Sturtevant Engineering Co. Ltd., 147 Queen Victoria Street, London.)



PROGRESSIVE KILN OF A.B.C. TYPE.

(Illustration lent by Erith's Engineering Co. Ltd., 70 Gracechurch Street, London.)



COMPARTMENT KILN (STURTEVANT SYSTEM) AT SCHNEIDER'S WORKS, FRANCE.

In the Sturtevant progressive kiln, air heated by contact with steam pipe coils is driven into one end of the dryer by means of centrifugal fans, and the timber after drying passes out at the other end. The air gathers moisture as it passes over the timber, and cools down. Green timber is entered at the air discharge end, where the temperature is low and the moisture high, and moves progressively through zones of increasing temperature and decreasing humidity, and finally emerges at the hot-air entry end.

The American Blower Company then developed a progressive kiln in which the circulation of the air was obtained by thermal means. Fans and motive power were not needed, and these kilns, being milder and more moist in their action, proved most useful for hard woods. The A.B.C. kiln, in its latest improved form, is known in this country as the " Erith " moist air dryer.

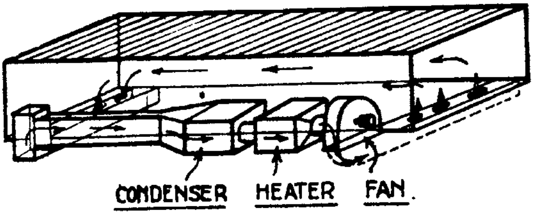
As progressive kilns are not adaptable for a mixed output, that is, for small quantities of varying kinds of thicknesses, such as are required for some works, compartment kilns were then developed. B. F. Sturtevant used fan-controlled ventilation, while with other processes fans or thermal circulation were the methods employed for ventilating the kilns. With thermal circulation each compartment is a separate unit, with its own radiator pipes, chimney, and other apparatus, and a drying plant consists of several of these units. With fan circulation, one fan and steam heater serves any number of compartments, all the machinery being in a separate chamber at the side of the drying rooms. The fan kiln has certain advantages over the thermal kiln. Firstly, less steam piping is required to radiate the same amount of heat, and consequently there are fewer joints to keep tight. As the steam pipe is outside the dryer it is under better observation. Finally, as the circulation is under mechanical control, the intensity of ventilation can be varied independently of alterations in the temperature, and " return air," or warm, moist air from the various compartments, gives a humid atmosphere suitable for the starting process, and therefore greater thermal efficiency.

In B. F. Sturtevant's compartment kilns the temperature in any one compartment was regulated by reducing or increasing the amount of hot air admitted, while the humidity was controlled by altering the proportion of return air taken by the fan. The disadvantage of this system was that any alteration to suit conditions in one room naturally altered those in others, while for very low temperatures the volume of air passing was so small that stagnation occurred in parts and mildew developed.

After many years of little appreciable progress, the British Sturtevant Company brought out their " Triple Duct " dryer. This, a great improvement on previous types, will be more particularly described later.

In America, thermal circulation has received most favour, and apart from the progressive kilns of the American Blower Company, numerous companies are selling compartment kilns all working on the thermal principle, and differing only in small details and accessories. The general basis of all these is a bank of steam pipe radiators under the floor of each compartment. The air is renewed by chimney draught, sometimes assisted by steam pipes or steam jets, and steam vapour is admitted under the timber to provide the humidity required when starting a charge, and generally to restrain the action of the heat.

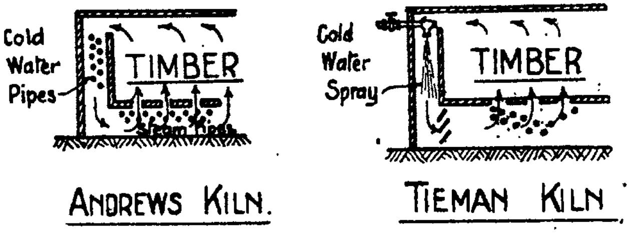
Apart from the two leading types of dryers, progressive and compartment, the only variant is the condensing kiln, which can be applied to either type. This was first fitted to fan-operated dryers, secondly to thermal kilns, and finally to kilns where thermal ventilation is assisted by the cooling and ejector action of water sprayers. The fan-operated condensing kiln (known as the Common-sense Dryer) could be either of the progressive or compartment variety. This had a closed circuit, and constantly re-circulated the same air. The wet air from the kiln passed over cold-water pipe coils which condensed the excess moisture. The air then passed to the heater, and thence back to the dryer. From a salesman's point of view this could be made very attractive, as it was possible to show a dryer at work with wet timber going in, dry timber coming out, and the extracted water trickling away from the condenser. However, as this system had no real advantage, after a brief period of popularity it ceased to be used.



The thermal circulation condensing kiln was devised by the Andrews Company. In this the hot-water pipes are, as in most cases, under the floor, the cold pipes of the condenser being in a side chamber. The direction of the circulation is upwards through the timber, and downwards in the side flue. Excess moisture is condensed from the wet air, which then passes to the radiator pipes and re-circulates.

The third variety of condensing kiln is that invented by Mr. H. D. Tieman, M.E., M.F., of the U.S.A. Forest Service. This is a development of the Andrews kiln, but instead of cold-water coils in the side flue, numerous water sprays are so directed as to assist the movement of the air in the desired direction. As the spray water is cooler than the hot wet air from the dryer, the moisture is condensed and the air returns to the heater, containing less moisture, and so after re-heating, is capable of doing further drying work. With this system fans and motors are unnecessary, but a pump system with automatic controls is required. The humidity is well under control, but the ventilation can only be varied within very small limits. The direction of movement of the circulating air is vertical. This means complicated piling, either edge-piling, which is only possible with square-edged timber, or an air space, broad below and decreasing towards the top, in the middle of the pile. These conditions present little difficulty in the laboratory, but are not so easy of execution in the timber yard.

There are other methods of extracting the water from timber. It can be baked out by putting the wood in contact with steam pipes. This can be done without splitting, if steam vapour is used to restrain the drying action. This treatment is, however, very drastic, and uniform drying is difficult unless the wood is absolutely desiccated. There is also the Hausbrand system of drying with superheated water vapour. In this, wet air is at first circulated, and the temperature is gradually raised. After reaching boiling point the air is allowed to escape, and the water vapour only circulates at such a temperature as to cause evaporation of the moisture in the wood. Wood can be dried by such means, but few people would risk their material under such a drastic process.



ANDREWS KILN.

TIEMAN KILN

TYPES OF CONDENSING KILNS.

The various systems may, therefore, be said to be reduced to the two main types of dryer, the progressive and the compartment, and to two ways of obtaining the circulation, that is, either by mechanical or thermal means. Accessories for working, such as water or steam sprays or hygrometers, can be applied to any of these.

PROGRESSIVE DRYERS

The actual treatment undergone by the timber must in general be the same whatever the type of dryer, if a satisfactory result is to be obtained. The terms " progressive " and " compartment " apply to the manner of moving the wood or controlling the thermal and hygroscopic conditions.

In all progressive kilns the timber is piled on trucks, and moved at regular intervals through zones of varying temperature and humidity. The heating apparatus and means of circulation are therefore arranged so that one end of the dryer is relatively cool and moist and the other end hot and dry. The intermediate space gives a gradual change from the cool, moist conditions to the hot, dry state. The length of time necessary for drying corresponds to the time taken to move the truck load through the dryer. A progressive dryer is essentially suited for dealing with large and regular supplies of one quality and thickness of timber. If two different thicknesses are put through the process for the same time, it is obvious that either the thicker will not be dry, or that the thinner will be over-dry. It is possible that several units could be installed, each working on one kind and thickness ; but each unit is necessarily large, as a considerable length is necessary to get good circulation, and as the width of the tunnel is fixed by the length of the longest plank. Generally speaking, one unit will deal with 60,000 super feet of 1 inch hardwood per month. The air circulation may be obtained either by fans or by thermal means. If fans are used, an electric motor or steam engine is required to supply the motive power.

With thermal circulation there is neither moving machinery, motors, engines, nor pumps. If the dryer is of proper proportions, the circulation and re-circulation of return air are found to be sufficiently active, as there is a constant source of heat at the heating coils, and a regularly renewed cooling effect from the fresh loads of cold, wet wood that are put in at regular intervals. Even if there were no outlet for the air, an internal circulation would be maintained. The air would rise naturally at the hot end, pass horizontally along through the stacked loads of timber, become depressed because of the cooling effect of the fresh material, and would finally return underneath through the space under the floor level. As saturation would be soon reached and drying cease if all outlets were closed, a wet-air outlet chimney is provided, while an inlet is allowed for fresh air to enter to replace that which is drawn off by the chimney.

For very heavy evaporations a fan-operated progressive dryer might be advantageous, as the thermal kiln would need some means such as steam jets or exhaust fans to assist in the circulation; but as a rule, for progressive dryers the thermal circulation shows to most advantage as regards ease of working, while it produces excellent results.

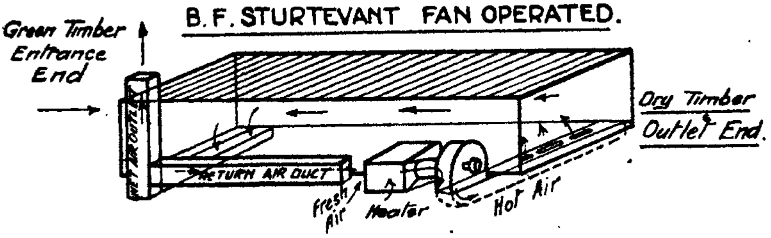
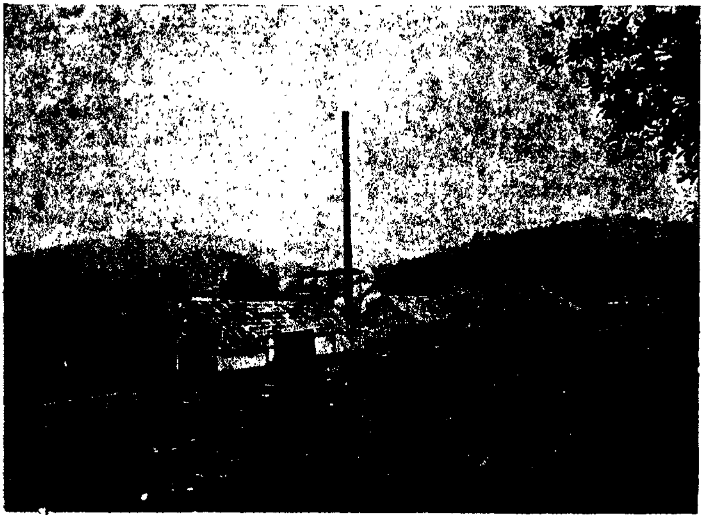


Diagram of Fan-operated Progressive Kiln.



Sturtevant Progressive Kiln.

Beech trees were felled and sawn, the timber dried and then planed in less than three weeks.

If a compartment kiln is very long and has doors at both ends, it can be operated in a semi-progressive manner. This is done by piling the timber on trolleys, and charging these into the compartment with the thinner material all to the discharge end. This thinner material will naturally dry more quickly than the rest, so that it can be taken out earlier, a longer time being allowed for the thicker plank.

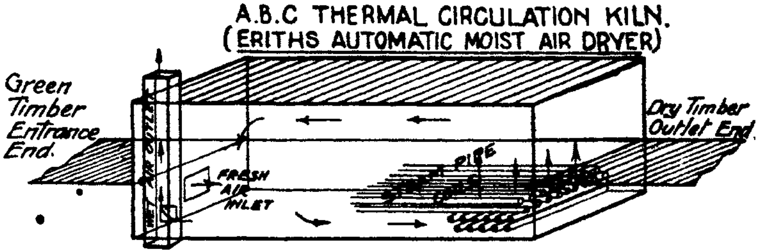
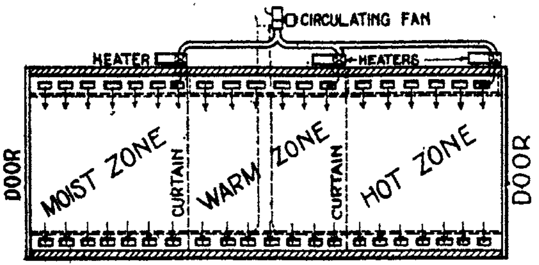

A.B.C THERMAL CIRCULATION KILN.
(ERITHS AUTOMATIC MOIST AIR DRYER)
Green Timber Entrance End.
Dry Timber Outlet End.
FRESH AIR INLET
PIPE

Diagram of Thermal Circulation Progressive Kiln.

Erith Moist Air Progressive Kiln at the Leyland Motor Co.'s Works, drying 1-inch Walnut for Aeroplane Propellers.

(Photograph by permission of Leyland Motors Ltd.)

Another hybrid arrangement is to divide the long compartment int three or more sections or zones, by means of doors or curtains, differen temperatures and humidities being maintained in each zone. With this, however, the ease of working attainable with a progressive dryer is



PLAN OF
THREE ZONE KILN.
TIMBER ON TRUCKS IS GIVEN A PERIOD FIRST IN THE MOIST ZONE, THEN IN THE WARM & FINISHED IN THE HOT ZONE

missed, without gaining the advantages of a properly designed compartment dryer.

COMPARTMENT DRYERS

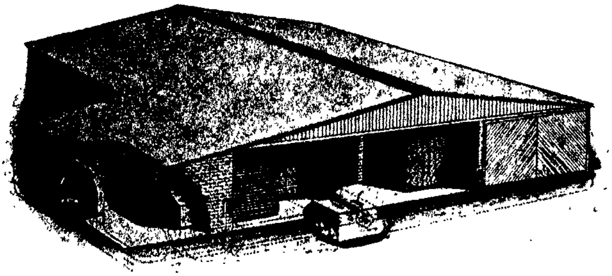
With compartment dryers the *régime* is the reverse of that in progressive dryers. In the compartment system the temperature is varied without movement of the material. A compartment dryer, as the name indicates, consists of a number of compartments or rooms. These are provided with heat either by steam pipes in the room itself, or from a heater outside. Ventilation and renewal of the air may be either by chimney draught or by the action of fans. Moisture for restraining the too rapid action of dry heat is provided by water spray or steam jets, and also by re-circulating a part of the warm, wet air from the dryer.

As the whole of the room is, or should be, at one even temperature, the only circulation that is possible by thermal means is by chimney draught. The contents of the compartment being warmer than the outside air, there would be a natural flow outwards through the chimney, replaced by an inward flow of cold air at floor level. The intensity of this action depends on the height of the chimney and the difference in temperature between the interior and the outside air. The circulation thus varies with the amount of heat, and can only be controlled negatively, that is to say, by shutting dampers in the chimneys. Makers of thermal compartment dryers usually provide either steam coils in the chimneys to accelerate the draught, or steam jet ejectors. Both of these prove somewhat inefficient, and consequently for all compartment dryers there is much to be said in favour of fan circulation.

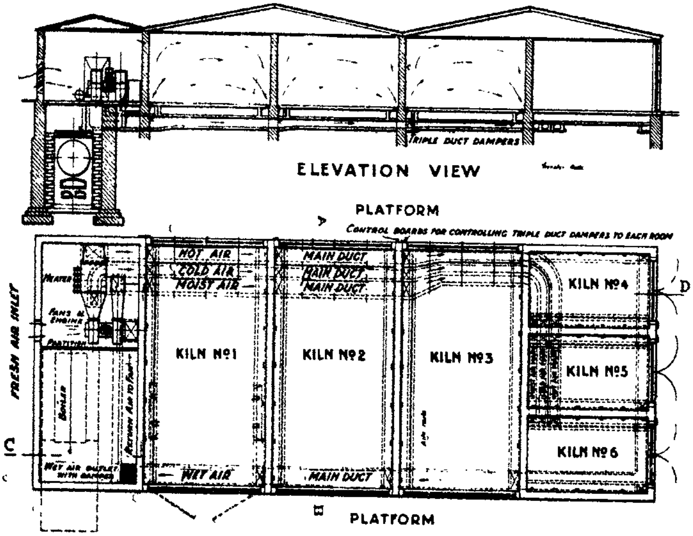
With fan-operated compartment dryers the heating is effected by means of hot air blown into the drying rooms by centrifugal fans. The air is heated by contact with steam-pipe heaters placed outside the rooms, and the necessary humidity is obtained by exhausting part of the used warm moist air from the dryer and re-circulating it. When greater humidity is needed, steam vapour is admitted. The temperature and humidity of the air injected can thus be varied quite independently of the circulation, which is in itself under control.

With the first fan-operated dryers this held good only when there was a single compartment. With two or more chambers working with one fan and one heater it was only possible to alter the temperatures in individual rooms by reducing or increasing the amount of air admitted, as otherwise the conditions in the remaining compartments would be interfered with.

The Sturtevant triple duct dryer, however, as has been said before,

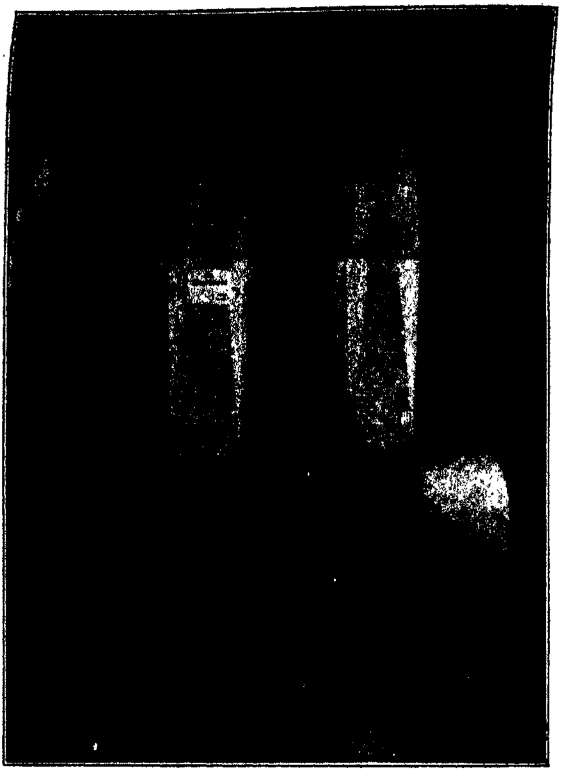


Sturtevant Triple Duct Dryer, showing Apparatus and Ducts.

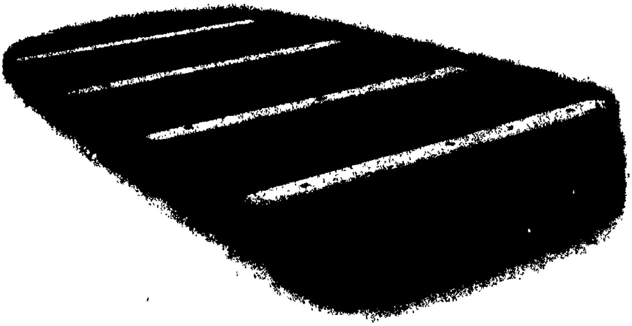


Sturtevant Timber Dryer at the Works of Messrs. W. W. Howard Bros. & Co., Poplar.

Multiple Heater Dryer by Sturtevant at the Works of The Great Western Railway Co., Swindon.
Erected principally for drying English ash for aeroplanes.



FANS, HEATERS, AND THE AIR DUCTS OF MULTIPLE HEATER DRYERS.



PILING TRUCK FOR TIMBER.

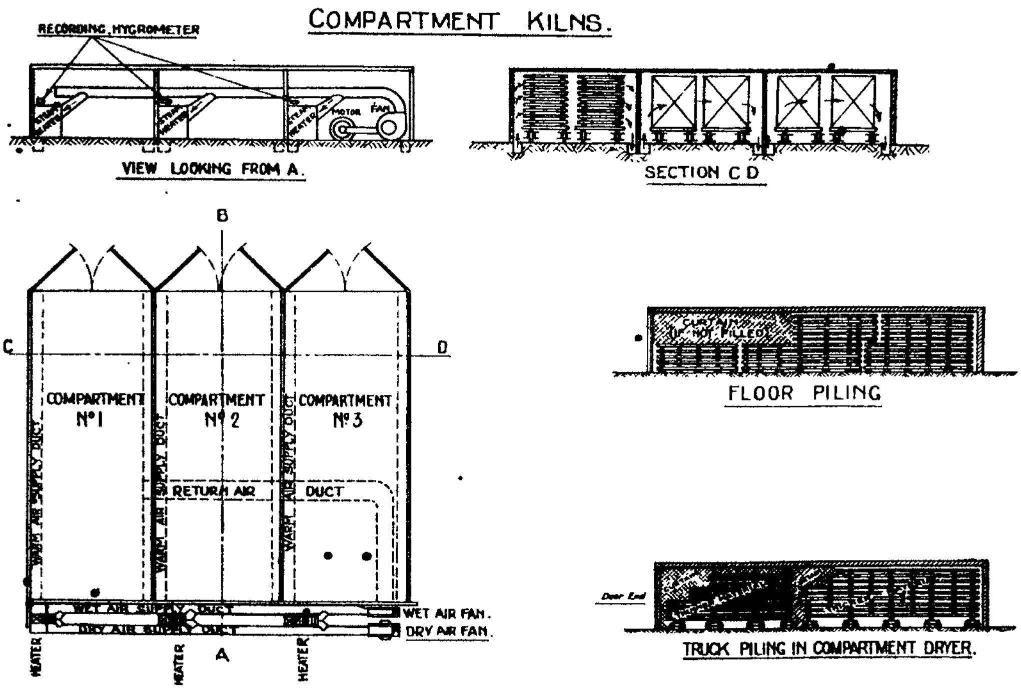


Diagram of Multiple Heater Dryer.

gave independent control in each compartment, and the three factors of ventilation, temperature, and humidity could be varied at will. As the name implies, there are three main air ducts, which respectively convey hot dry air, cold dry air, and moist air. The dry air, both hot and cold, is taken from the outside by a centrifugal fan which injects some part directly into the cold duct, and the remainder to a steam pipe radiator and thence to the hot duct. The wet air is drawn from the drying rooms, and is therefore generally termed "return air." The three main ducts run across the ends of the various compartments, and any required mixture of the three kinds of air can be admitted to the compartment by dampers. By having hot air and cold air on supply to each compartment the temperature can be varied without interfering with the ventilation. Humid air is also available, and the amount to be admitted is regulated according to requirements.

In theory, this system gives ideal control, but there are certain mechanical disabilities. For instance, if the hot-air damper does not shut hermetically, the small leakage of very hot air makes it difficult to get a low starting temperature. Again, if the construction of the ducts is not perfect, or if they are in damp ground, there is a serious loss of heat, and frequently the air in the cold duct gets too hot owing to heat radiating from the hot duct.

To eliminate these difficulties, a variation of the triple duct dryer was devised by the writer. With this system there are only two main ducts, one for return air and the other for cold dry air. As no hot air is moved through ducts, there are no radiation losses. Then, instead of one main heater for the whole plant, a separate steam pipe heater for each compartment is used. Instead of the temperature being controlled by an air damper, it is varied by the steam stop-valve on the heater. This can be entirely shut off when no heat is required, or opened to give any desired degree of heat. A steam valve is more reliable in closure than an iron air damper, and can also give finer adjustment.

Very accurate working can be effected with these "Multiple Heater" dryers, and a predetermined course as to temperature and humidity can be followed whilst maintaining a constant ventilation.

Compartment dryers can be in much smaller units than can the progressive type for a given length of plank, and for some kinds of work it is more convenient to have three or four small rooms than one large one; where, for instance, supplies of several kinds and thicknesses of timber are required, and where the total output would not warrant having several progressive dryers. The reason that small compartment units can be made, lies in the fact that the lengths need only be that of the plank, whereas in a progressive dryer greater length is necessary for giving a difference in temperature. The width of a progressive dryer has to be greater than the length of the longest plank, but a compartment dryer may be quite narrow.

The general distinction, therefore, between progressive and compartment dryers is not technical or proprietary, but rather administrative. Both can do equally good work, but they are suited to different requirements.

CONTROL OF DRYING PLANTS

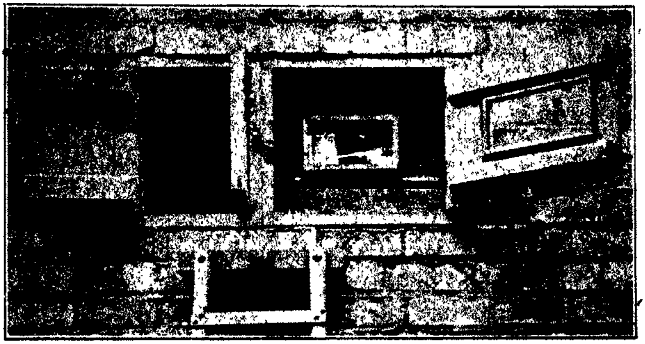
While it is perhaps possible to work a drying plant by rule of thumb, with the aid possibly of a few thermometers or a hygrometer, it has been proved that consistently good results can only be maintained if the plant is worked in a scientific manner with proper instruments to show what is happening inside the dryers, and to keep autographic records. Recording instruments have a twofold use: firstly, to ensure that attendants pay proper attention to their work; and secondly, to find out and record the best processes for different timbers, so that it is possible to repeat or to improve on these which are successful, and discard those which are unsatisfactory.

The ordinary mercury thermometer is the basis of all readings, both directly for temperature and indirectly for humidity. The degree of humidity is indicated by the difference in readings between two thermometers, one of which is of the normal type, while the bulb of the other is covered with muslin, which is kept moist by a wick dipping into a water tank.

This combination is called the " wet and dry bulb " hygrometer. The dry bulb gives the temperature direct. On the wet bulb there are two influences, the heat of the surroundings which would raise the mercury to the same level as in the dry bulb thermometer, and the cooling effect caused by the evaporation of the moisture in the muslin round the bulb. If the air is completely saturated with moisture, this evaporative effect will be absent, and the two thermometers will read equal. If the air is dry, the evaporation will be considerable and the wet bulb will show a lower reading than the dry bulb. The amount of the difference between the two readings, together with the dry bulb reading, gives a correct indication of the humidity and temperature in the dryer.

By means of calculations, tables or charts (hygrodyks), it is possible to work out the humidity in percentages of saturation, but there is no advantage to be gained by this. There are also instruments which give the percentage readings direct. These use the tightening or slackening of a bunch of hairs, or the curling or uncurling of a spiral of fibre, owing to variations of moisture, to operate an indicating needle on a dial. Such instruments may be correct when new, but as they are very delicate and soon get out of order, they are quite unsuitable for practical work.

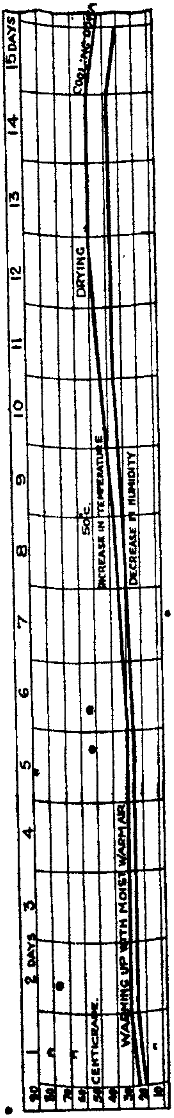
The wet and dry bulb mercury thermometers are therefore the basis of all readings. These, however, in the ordinary form, have to be observed frequently, and the readings noted down. In order to keep a continuous and autographic record of the conditions in the dryer, the recording wet and dry bulb hygrometer is used. This instrument is made in two forms, similar in general principles, but differing as to the form of chart used. The one type carries the paper on a circular dial, and is limited to a certain number of days per chart (generally 7 days), and the other winds up the paper on to a drum, and can take charts of considerable length, the unused part being wound on a spool.



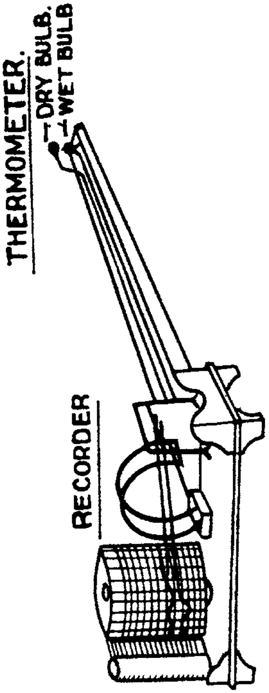
RECORDING HYGROMETER (ALSO THERMOMETER) AS PLACED IN ERITH DRYER.

RECORDING HYGROMETER IN STURTEVANT DRYER.

The dial or the drum is moved by clockwork, and the expansion or contraction of the mercury in the bulbs, due to variations in temperature, operates pens which mark the wet and dry bulb readings on the chart. The pen arms of the recorder are provided with screws so that the



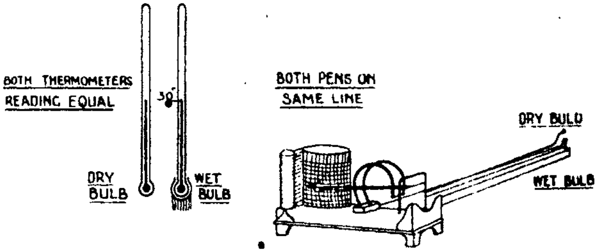
Recording Hygrometer and Guide Chart for 1-inch Walnut Boards.



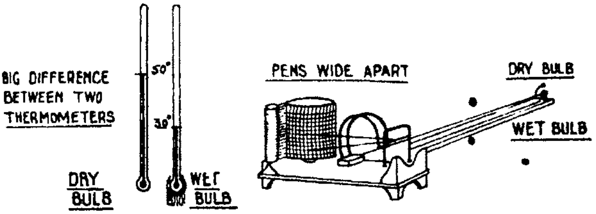
instrument can be corrected from time to time to agree with the wet and dry bulb thermometers.

With an Erith or other progressive dryer, the recorder bulbs are placed in the dryer near the hot end. The records should show either two concentric circles in the case of a dial instrument, or two parallel lines with the drum type.

There are, of course, unavoidable fluctuations due to opening of doors and the like, but for good working the wet and dry bulb readings should be practically steady.



THERMOMETERS READING EQUAL, OR RECORDER PENS TOGETHER INDICATES WET AIR IN KILN



BIG DIFFERENCE BETWEEN THERMOMETERS OR RECORDER PENS INDICATES DRY AIR IN KILN

With compartment dryers, where the temperature and humidity are varied according to a predetermined course, the temperature line will rise gradually from atmospheric temperature to full heat, and the wet bulb line will start close to the temperature line (indicating great moisture), and gradually fall away from it as drier air is used.

The above diagrams show the analogy between the wet and dry bulb thermometers, and the recorder, under extremes of wetness and dryness.

Having in view the wide variations in the quality of timber, it is not possible, of course, to make for any particular kind a formula which would prove infallible. The charts are but guides, and although they represent the treatment for average timber of the kind, deviations are necessary to meet special cases. The recording hygrometer serves a double purpose, as with the chart it shows the course to be followed, and the record of the pens show whether the proper attention has been given, and steam maintained, while in cases of deviation from the standard chart, a record remains for future guidance.

WORKING PROCEDURE

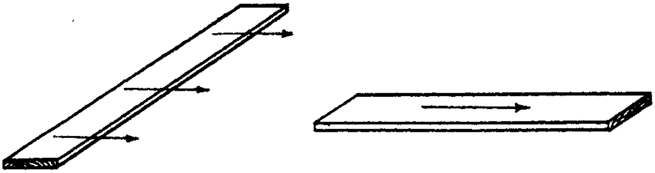
The following instructions and illustrative sketches for working timber dryers are derived mainly from the "Procedure for Kilns," A.B.I. No. 255, of the Aeronautical Inspection Directorate, which procedure was drawn up and inaugurated by the writer during his service with the Department. Permission to use this matter is gratefully acknowledged to the Director, Brigadier-General Bagnal-Wilde.

Many millions of feet of aircraft timbers have been successfully treated in accordance with this procedure under the supervision of the A.I.D. Methodical working is all important. The timber must be carefully stacked and arranged in the dryer, so that the circulating air is brought into contact with all the boards and does not pass uselessly through gaps in the piles.

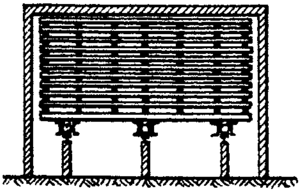
The piling sticks, of which there should be a sufficient number of the right size, must be dry. After a dryer has been at work for some time, the sticks are naturally quite dry, but when starting a new installation it often happens that new sticks are cut from green timber for immediate use. These should be put in the dryer by themselves, and dried before being used in stacking. If wet sticks are used, the strip across the plank which has been in contact with the stick will probably be stained, and will certainly be wetter than the remainder. Piling sticks 1 inch square are the most useful size. Smaller ones should not be used even for the thinnest material, as the circulation would be poor. For very thick material it is often advisable to use sticks 1½ inch or even 2 inches thick in the lower part of the pile, in order to assist the flow of air through the piles. As a general rule, it may therefore be said that piling sticks should be 1 inch thick for planks up to 2 inches thick. For thicker timber, 2-inch piling sticks should be used in the lower part of the stack (from floor to one-third of the height), and 1-inch sticks for the remainder.

The timber must be piled evenly, filling as far as possible the whole cross section of the dryer. The circulating air will naturally take the easiest course, and if free passages are left, the drying air will not come into contact with all the timber, and the drying will be uneven. Canvas curtains should be placed across any unavoidable spaces, or some similar device employed to ensure that the drying air is properly utilised.

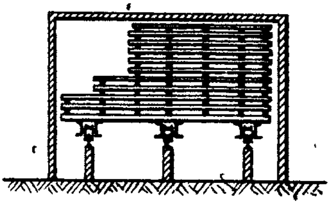
With progressive dryers the boards should be stacked to pass through the dryer broadside on; if passed through lengthwise, the drying is not uniform.



The timber should be piled evenly, filling the whole cross section of the tunnel. This, however, though certainly the ideal method, is but rarely possible.



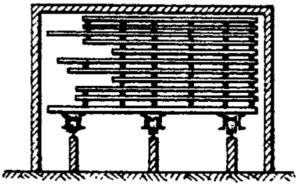
IDEAL.



GOOD.

Before commencing the stacking of a truck, the boards should be sorted into lengths. The shorter boards can often be paired to make a full width, the longer boards are stacked on these, and those of medium length are ranged above. One side of the load is made vertically even to fit closely to the side of the dryer.

If the boards are taken at random, the result is somewhat like this:



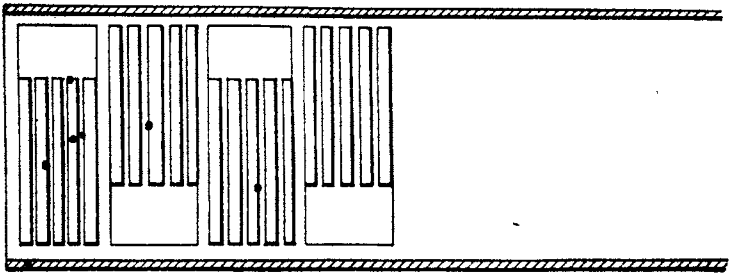
BAD

This means the warping and splitting of the exposed ends. As it is admitted that the ideal is not possible, and that there will be a space on each load at one side, it should be arranged that these spaces do not follow one another. The loads can be stacked dressing alternately to the right and to the left.

By this means a straight blow through the dryer is avoided.

The piling sticks must be placed exactly one above the other. More care is required in stacking when seasoning artificially, than for natural air drying. The end sticks must be right up to the end of the board.

Metal cleats do no harm, but wood cleats, far from preventing splitting, often cause it, and should therefore not be used. The protection given to the end of the plank by having a piling stick above and below, is better than any cleat, as the latter becomes useless or worse, as soon as shrinkage takes place. The thickness of the piling sticks fixes the space between the boards. The edges should not be together, but 1 inch or more left between each board.



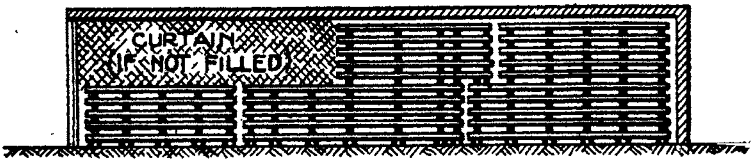
TRUCK LOADS DRESSING ALTERNATELY TO RIGHT & LEFT

With compartment dryers, the timber is sometimes piled directly on the floor, in other cases it is stacked outside on kiln trucks, and the truck loads pushed into the dryer, and withdrawn after treatment. In either case a full charge is desirable, and any avoidable gaps in the pile should be blocked by curtains.

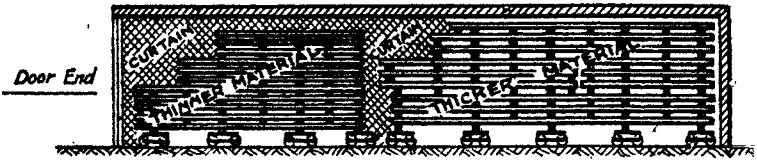
If there is material for only half a charge, it is well to fill the whole length, making a narrower width.

As in the case of progressive dryers, the planks should be sorted to length, and paired in order to avoid any overhanging. Where planks are of irregular shape, as resulting from logs sawn through and through, the butt ends must be kept to one side, and be in a vertical line. The top ends may be somewhat uneven, but being lighter, can be more easily supported.

With regard to moisture test samples in progressive dryers, one test per load of about 250 boards is ample. When the dryer is running constantly on one consignment, and regular results are being obtained, the number of tests can be diminished to about one every three loads. Compartment dryers generally hold very much more per charge, and two or three samples should be drawn representing 1000 cubic feet or more of material. If there is any variation in the thickness, a sample from each is required. These samples are taken in the first place from the green plank, and the moisture result is a guide as to the length of process required. When it appears to be approaching completion, a further sample is taken from the same planks, and it is thus ascertained if the requisite dryness has been attained.



FLOOR PILING



TRUCK PILING IN COMPARTMENT DRYER.

Supervision.—A timber dryer must work continuously, day and night, as well as on Sundays. Apart from the bad effects of changes in temperature, there is no economy in working only in the daytime, as the heat cannot be resumed after a stoppage at the point arrived at before it ceased, but must be regained gradually. The loss of time is therefore much greater than the actual time of stoppage. The dryer must be definitely in the charge of some responsible person who is capable of attending to the instruments, of making moisture tests and keeping records. This does not mean that his whole time will be occupied on the dryer, but that visits must be made at regular intervals during the day-time, and occasional superintendence provided for during the night. Records of what is happening between the visits are kept by the recording instruments.

Besides splitting and warping, which are very obvious faults, there is an error which can be made in drying timber which is not apparent to the eye, but which is quite as harmful. If the restraining action of moisture is omitted or improperly controlled, there is a tendency for the surface of the timber to dry and harden to such an extent that it becomes quite impervious to the passage of moisture, thereby preventing the interior from drying, even if given a much longer time than usual. If the timber is discharged in this "case-hardened" condition, and then sawn up, the wet interior wood would lose its moisture and shrink, while the surface wood remained dry. The result would be bad warping and twisting. Case-hardened wood can sometimes be corrected by thoroughly wetting the surface with hot vapour, and then resuming the normal drying process, but the surface wood will be found to be deteriorated, and a microscope shows that the cells are deformed and broken. Case-hardening is a fault that is due to careless and hurried working, occurring chiefly where the timber is being partially dried to reduce freight. It need not occur if the process is carefully conducted.

The whole success of the drying depends on intelligent working, and the proper use of technical data. The difference between rule of thumb and scientific working shows in the quality of the dried timber, and lack of proper attention is false economy.

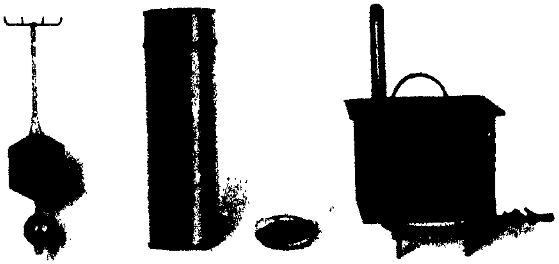
TESTS.—It has not formerly been customary for those who use timber to experiment upon it, to determine either its strength as a species in general, or the individual qualities of some particular parcel. Yet data of much practical advantage can be obtained by such experiments, provided that a sufficiently large number of tests are made, and that the specimens chosen are thoroughly representative of the species or parcel under consideration. It is most important, however, to use tests which represent as nearly as possible the actual working conditions under which the timber is to be employed. It is, for instance, of little use to make compression tests only on timber which is to be used for aeroplane propellers, where the chief stress will be in bending, or bending tests in wood for wheel spokes, where resistance to compression is needed. In all cases, however, tests for dryness are essential, particularly where artificial seasoning processes are employed.

There are two kinds of tests: laboratory tests and working tests, which take place either in the factory or at the dryer. The former are divided into two categories; botanical, which deal with the structure of the wood, and mechanical, in which the material is subjected to trials such as endurance in compression, bending, torsion, tension, the determination of Young's modulus, and the modulus of rigidity. In connection with all these tests, the water content of the specimen is assayed, and the density, or weight per cubic foot, is calculated.

Working tests are more simple, the principal object being to determine the percentage of moisture in the wood, in order to ascertain, in the case of green timber, what degree of drying is necessary, or in the case of partly seasoned wood, to find out the exact stage which has been reached in that process. Simple breaking tests can also be made on small specimens, which will show approximately whether the material is capable of the usual breaking load. Examination of the fracture thus made is of great use in determining whether the wood is tough or brittle.

The alternative to making moisture determinations is the exercise of private judgment, which is notoriously fallible. It is therefore preferable to find out the exact percentage of moisture in seasoned wood, and then use moisture tests to see that the timber is dried to a corresponding percentage.

A very simple apparatus has been designed by Lieutenant Kennedy of the Aeronautical Inspection Directorate, for determining the moisture content in wood. It consists of an hydrometer balance for weighing, and a gas-heated oven for drying out the sample. The hydrometer is graduated to take a convenient quantity of wood chips which contain an unknown amount of moisture, when sunk to the zero mark. After baking out the moisture from the sample, and consequently reducing its weight, the scale shows directly the percentage of moisture which these wood chip samples contained.



It is a great mistake to dry out the timber completely. If wood is "bone dry" it is as dead as a bone. Timber thoroughly seasoned by natural means contains anything between 9 per cent to 15 per cent of moisture, and as this may be regarded as being the standard of excellence, it forms a guide for artificial seasoning. It is easier, as far as working is concerned, to dry out completely, and then allow the material to reabsorb moisture from the atmosphere, but this should be avoided in all cases where brittleness would be a disadvantage.

Degrees of dryness should vary according to the use to which the timber will be put. For inside work, such as joinery, furniture, and wood-block flooring, where thorough dryness is necessary, 8 per cent to 10 per cent moisture should be allowed, though for export to the tropics the amount should be no more than 6 per cent. For outside work, such as coach-building, 10 per cent to 15 per cent would be the normal amount, and for special cases, such as shafts, stretcher poles or aeroplane langerons, where flexibility is all-important, and a little shrinkage is immaterial, an even greater amount of moisture should be left in the timber. In general, where the ultimate purpose for which the timber will be used is unknown, the seasoning process should be operated so as to retain between 12 per cent to 15 per cent in the seasoned wood.

WHICH IS BETTER—NATURAL OR ARTIFICIAL SEASONING?

The subject of artificial seasoning having been now presented, comparisons between it and ordinary air seasoning naturally arise. It has been shown that artificially seasoned timber has been considered by the Air Board as fit and proper for use in an aeroplane propeller or langeron, and it may be concluded, therefore, that it is also good enough for a sideboard or a cart. It is in fact practically impossible either for the professor with his microscope, or the practical timber man with his knife, to tell the difference between naturally seasoned and properly artificially seasoned timber, if the surface is planed off.

The question must be considered both from a technical and a commercial point of view. The chief technical advantage of artificial seasoning is that it is possible to obtain with considerable precision any degree of dryness which may be required for a particular purpose. In some cases it is not desirable to have the timber completely dry, in others it is an advantage to have it somewhat over-dry, so that there can be no possible chance of shrinkage. Either of these objects may be attained by shortening or lengthening the normal process. In the light of commercial interests, there are arguments favourable and unfavourable to be adduced. The purchase of fresh timber which can be artificially seasoned within a month, is a distinct advantage, since it becomes thereby unnecessary to hold large stocks, and thus tie up considerable capital. There have been calculations made which have taken account of interest on tied capital, rent, and so forth, which have been used as an argument justifying the capital outlay necessary to establish an artificial drying plant; but, on the other hand, it has been argued that the costs of establishing and working the plant will exceed that of the stocks which must otherwise be held.

The solution lies less in discussing this disputed question than in turning to consider which type of seasoned timber is of the greater value. It is well known amongst those who have carried out high-class work, that in spite of every effort made to keep a sufficient stock of thoroughly naturally-seasoned wood, this should always undergo a certain amount of artificial seasoning before use.

With the knowledge which we now possess as the result of experience during the war, it appears almost certain that better results can be obtained from artificially seasoned timber than is possible with that which is naturally seasoned. Such tests as have been applied have not, it is true, been conclusive, but those who have an extensive experience of the processes in question are of the opinion that such tests, when completed, will justify their confidence in the technical merits of the artificial seasoning process. If it can be proved that it does ensure constructive or manufactured work of a better character, then, even if its application were more troublesome at first, it would clearly, in the course of time, justify itself commercially as well as technically.

CLASSIFICATION OF TIMBERS ACCORDING TO COUNTRY OF ORIGIN

THE TIMBERS OF AFRICA

Barwood (*Pterocarpus angolensis*, DC.; *P. santalinoides*, L'Hérit.).
Blackwood (*Dalbergia Melanoxylon*, Guill. and Perr.).
Boxwood, African or East London (*Buxus Macowani*, Oliv.).
Boxwood, Knysna (*Gonioma Kamassi*, E. Mey.).
Cedar, African Pencil (*Juniperus procera*, Hoch.).
Cedar, Red (*Cunonia capensis*, Linn.).
Cedar, True (*Cedrus atlantica*, Manetti).
Cedar, West African.
Coromandel wood (*Diospyros* sp.).
Ebony (*Euclea Pseudebenus*).
Ebony, African (*Diospyros Dendo*, Welw.).
Furniture-wood.
Iroko (*Chlorophora excelsa*, Benth. and Hook.).
Ironwood, East African.
Mahogany.
Moeri.
Oak, African (*Lophira alata*, Banks).
Padauk (*Pterocarpus santalinoides*, L'Hérit., *P. angolensis*, DC.).
Prima Vera.
Sabicu.
Satinwood, African (*Acacia* sp. ?).
Sneezewood (*Pteroxylon utile*, Eck. and Z.).
Walnut, African (*Lovoa Klaineana*, Thompson).
Yellow-wood, African.

THE TIMBERS OF CENTRAL AMERICA AND THE WEST INDIES

Abey (*Poeppigia excelsa*, A. Rich.).
Abey Macho (*Hedwigia balsamifera*).
Acana or Almique.
Almond-wood or Cuba Almond.
Baywood.
Boxwood, West Indian (*Tecoma pentaphylla*, Juss.).
Brazil-wood (*Caesalpinia echinata*).

Cabilma or Cabirma (*Cedrela angustifolia*, Moç and Sesse).
Canalete.
Cedar, Cigar-box (*Cedrela odorata*, Linn.).
Cedar, Pencil (*Juniperus virginiana*, Linn.).
Cheese-wood (*Erythrina* sp. ?).
Cinnamon.
Cocobolo.
Cocus-wood (*Brya Ebenus*, DC.).
Degami-wood (*Calycophyllum candidissimum*, DC.).
Ebony, Green (*Tecoma Leucoxylon*, Mart. ?).
Greenheart (*Nectandra Rodioei*, Hook.).
Harewood or Concha Satinwood.
Koa (*Acacia Koa*).
Lalone.
Lancewood (*Guatteria virgata*, Dun.).
Lignum Vitae (*Guiacum officinale*, Linn.).
Locust (*Hymenoe Courbaril*, Linn. ?).
Logwood (*Haematoxylon canapectianum*, Linn.).
Mahoe, Blue (*Hibiscus elatus*, Sw.).
Mahogany (Costa Rica, Cuba, Honduras, Panama).
Mahogany, Spanish (*Swietenia Mahogani*, Linn.).
Pimento (*Pimenta officinalis*, Linn.).
Prima Vera.
Quassia (*Picraena excelsa*, Lol.).
Sabicu (*Lysiloma Sabicu*, Benth.).
Santa Maria (*Calophyllum Calaba*, Jacq.).
Satinwood, West Indian (*Zanthoxylum* sp.).

THE TIMBERS OF NORTH AMERICA

Acacia (*Robinia Pseudacacia*, Linn.).
Arbor Vitae (*Thuja occidentalis*, Linn.).
Ash, American (*Fraxinus americana*, Linn.; *F. sambucifolia*, Lam.).
Barberry (*Berberis vulgaris*, Linn.).
Basswood (*Tilia americana*, Linn.; *T. heterophylla*, Vent.; *T. pubescens*, Ait.).
Big Tree (*Sequoia gigantea*, Decaisne).
Birch (*Betula alba*, Linn.; *B. lenta*, Linn.).
Buckeye, Ohio (*Aesculus octandra*, Marsh; *A. glabra*, Willd.).
Butternut (*Juglans cinerea*, Linn.).
Cedar, Pencil (*Juniperus virginiana*, Linn.).
Cedar, Port Orford (*Cupressus Lawsoniana*, Murr.; *Chamaecyparis Lawsoniana*, Sarg.).
Cedar, Red (*Thuja gigantea*, Nutt.; *Juniperus occidentalis*, Hook.).
Cedar, White (*Libocedrus decurrens*, Torrey; *Cupressus thyoides*, Linn.).
Cedar, Yellow (*Cupressus nootkatensis*, Hook.).
Cypress, Marsh (*Taxodium distichum*, Richard).
Elm (*Ulmus americana*, Linn.; *U. racemosa*, Thomas, etc.).
Elm, Wych (*Ulmus montana*, Sm.).
Hickory (*Hicoria ovata*, Britt.; *H. alba*, Linn., etc.).
Hornbeam (*Carpinus Betulus*, Linn.).
Magnolia (*Magnolia acuminata*, Linn.).
Maple (*Acer saccharinum*, Wang.; *A. saccharum*, Marsh).

Oak (*Quercus alba*, Linn., etc.).
Oak, Live (*Q. virens*, Ait.).
Orham-wood (*Ulmus* sp.).
Ossage-orange (*Toxylon pomiferum*, Raf.; *Maclura aurantiaca*, Nutt.).
Persimmon-wood (*Diospyros virginiana*, Linn.).
Pine, Oregon (*Pseudotsuga Douglasii*, Carr.).
Pine, Pitch (*Pinus palustris*, Miller, and *P. rigida*, Miller).
Pine, Tonawanda.
Pine, Yellow or White (*P. Strobus*, Linn.).
Sequoia (*Sequoia sempervirens*, Endl.).
Service-tree (*Pyrus torminalis*, Ehrh.).
Spruce, Hemlock (*Tsuga canadensis*, Carr.).
Tamarack (*Larix americana*, Mich.).
Tupelo (*Nyssa sylvatica*, Marsh., or *N. uniflora*, Wang.).
Walnut, American Black (*Juglans nigra*, Linn.).
Walnut, Satin (*Liquidambar styraciflua*, Linn.).
Whitewood, or Canary Whitewood (*Liriodendron tulipifera*, Linn.).

THE TIMBERS OF SOUTH AMERICA

Acapu.
Aderno ((*Astronium commune*, Jacq.).
Alerce (*Fitzroya patagonica*, Hook.).
Amarant or Amarante.
Angelim-rosa (*Peraltea erythrinaefolia*, Mart.).
Angélique (*Dicorynia paraensis*, Benth.).
Angico (*Piptadenia rigida*, Benth.).
Arariba amarello (*Centrolobium robustum*, Mart.).
Arariba vermelho (*C. tomentosum*, Benth.).
Araucaria (*Araucaria imbricata*, Pav.).
Aroeira do Sertão (*Astronium urundueva; Myracrodon urundeuva*, Fr. Allem.).
Beefwood (*Mimusops globosa*, Gaert.).
Boxwood, Venezuelan (*Tecoma pentaphylla*, Juss.).
Brauna Parda (*Melanoxylon brauna*).
Canella-Preta (*Nectandra mollis*, Nees).
Canella-Tapinhoan.
Cangerana (*Cabralea cangerana*, Sald. Gam.).
Cedar, Guiana (*Protium altissimum*, Marsh).
Cedar, Paraguay (*Cedrela braziliensis* ?).
Chibatan.
Cocobolo.
Crabwood (*Carapa guianensis*, Aubl.).
Curupay (*Piptadenia Cebil*, Grisebach).
Freijo.
Goncalo Alves (*Astronium fraxinifolium*, Schott.).
Grapia-punha (*Apuleia precox*, Mart.).
Greenheart (*Nectandra Rodioei*, Hook.).
Guarabu (*Terminalia acuminata*, Fr. Allem.).
Ipê preto or Ipê una (*Tecoma curialis*, Fr. Allem.).
Jarana Preta.
King-wood.
Mahogany, Colombian (*Cariniana pyriformis*).
Mahogany, Guatemalan.

Mata-mata.
Messaranduba (*Leucuma procera*, Mart.; *Mimusops elata*, Fr. Allem.).
Mora (*Dimorphandra Mora*, Benth. and Hook.; *D. excelsa*, Baill.).
Nutwood (*Dicorynia Maraensis*, Benth.).
Oleo Vermelho (*Myrospermum Erythroxylon*, Fr. Allem.).
Páo-Rosa (*Physocalymma floridum*, Pohl.).
Partridge-wood (*Andira* sp.).
Pau Amarello.
Peroba Branca.
Peroba Rosa (*Aspidosperma Peroba*, Fr. Allem.).
Piquia.
Purpleheart (*Peltogyne paniculata*, Benth.).
Quebracho.
Rosewood, Bahia, and Rosewood, Rio (*Dalbergia* sp. and *Machoerium* sp.).
Satinee (*Ferolia guianensis*, Aubl., or *F. variegata*, Lam. ?).
Sicupira amarella (*Bowdichia nitida*, Spr.).
Snakewood or Letter-wood (*Brosimum Aubletii*, Sw.).
Tapinhoan (*Silvia navalium*, Fr. Allem.).
Teak, Surinam.
Tulip-wood (*Physocalymma scaberrimum*, Pohl.).
Ubatan.
Vera-wood.
Vinhatico (*Echirospermum Balthazarii*, Fr. Allem.).
Wallaba (*Eperua falcata*, Aubl.).
Wana (*Nectandra Wana* and *N. Pisi*).
Washiba.

THE TIMBERS OF AUSTRALIA, TASMANIA AND NEW ZEALAND

Akeake (*Olearia aricenniaelobia*).
Banksia (*Banksia littoralis*, R. Br.).
Beech, Tasmanian (*Fagus Cunninghamii*, Hook.).
Blackbean (*Castanospermum australe*, A. Cunn.).
Blackbutt (*Eucalyptus pilularis*, Sm.; *E. patens*, Benth.).
Blackwood (*Acacia Melanoxylon*, R. Br.).
Cedar, Moulmein (*Cedrela Toona*, Roxb.).
Cedar, Red Australian.
Cheese-wood, Tasmanian (*Pittosporum bicolor*, Hook.).
Gum, Blue (*Eucalyptus Globulus*, Labill.).
Gum, Red (*E. calophylla*, R. Br.).
Gum, Salmon (*E. salmonophloia*, F. v. M.).
Gum, Spotted (*E. capitellata*, Sm.).
Gum, York (*E. Loxophleba*, Benth.).
Hinau (*Eleocarpus dentatus*, Vahl).
Horoeka (*Pseudopanax crassifolium*).
Ironbark (*Eucalyptus largiflorens*, F. v. M.).
Jarrah (*E. marginata*, Sm.).
Karri (*E. diversicolor*, F. v. M.).
Kowhai (*Sophora tetraptera*, Ait.).
Maire, Black (*Olea Cunninghamii*, Hook).
Mangeao (*Litsaea calicaris*, Benth. and Hook).
Manuka (*Leptospermum ericoides*, A. Rich.).

Matai (*Podocarpus spicata*, R. Br.).
Miro (*P. ferruginea*, Don).
Morrell (*Eucalyptus longicornis*, F. v. M.).
Myall (*Acacia pendula*, A. Cunn.).
Oak, Silky (*Grevillea robusta*, A. Cunn.).
Pahautea (*Libocedrus Bidwilli*, Hook.).
Pear, Native (*Xylomelum occidentale*, R. Br.).
Pine, Celery Top (*Phyllocladus rhomboidalis*, Rich.).
Pine, Huon (*Dacrydium Franklinii*, Hook. f.).
Pine, Kauri (*Agathis australis*, Salisb.; *Dammara australis*, Lamb.).
Pine, King William (*Athrotaxis selaginoides*, Don; *A. cupressoides*, Don).
Pine, New Zealand (*Podocarpus dacrydioides*, A. Rich.).
Pine, Silver (*Dacrydium Westlandicum*, T. Kirk.).
Pohutukawa (*Metrosideros tomentosa*, A. Cunn.).
Pukatea (*Laurelia Novae Zelandiae*, A. Cunn.).
Puriri (*Vitex littoralis*, Dcne.).
Raspberry Jam-wood (*Acacia acuminata*, Benth.).
Rata (*Metrosideros robusta*, A. Cunn.).
Rewa-rewa (*Knightia excelsa*, R. Br.).
Rimu (*Dacrydium cupressinum*, Soland.).
Sandal-wood (*Santalum cygnorum*, Miq.).
Sheoak (*Casuarina Fraseriana*, Miq.).
Stringy-bark (*Eucalyptus obliqua*, L'Hérit.).
Tallow-wood (*E. microcorys*, F. v. M.).
Taraire (*Beilschmiedia Tarairi*, Benth. and Hook. f.).
Tawhai (*Fagus fusca*, Hook. f.).
Titoki (*Alectryon excelsum*, Gaert.).
Totara (*Podocarpus Totara*, A. Cunn.).
Towhai (*Weinmannia racemosa*, Linn.).
Tuart (*Eucalyptus gomphocephala*, DC.).
Turpentine (*Syncarpia leptopetala*, F. v. M.).
Wandoo (*Eucalyptus redunca*, Schau.).
Wattle, Silver (*Acacia dealbata*, Link.).
Yate (*Eucalyptus cornuta*, Labill.).

THE TIMBERS OF BORNEO AND THE PHILIPPINES

Amboyna.
Apitong (*Dipterocarpus grandiflorus*, Blanco).
Bedaru (*Urandra* sp.).
Betis (*Illipe betis*, Blanco).
Billian (*Eusideroxylon Zwageri*, T. and B.).
Camphor-wood, Borneo (*Dryobalanops aromatica*, Gaert.).
Chingal (*Balanocarpus* sp.).
Ebony (*Maba buxifolia*, Pers.).
Empata or Empadu (*Pterocarpus Rassak*).
Guizo.
Kranji (*Dialium indum*, Linn.).
K'runtum (*Helicia* sp. ?).
Lauan.
Lumbayao (*Tarrietia javanica*, Bl.).
Meranti (*Hopea* sp.).

Mingris (*Koompassia Beccariana*, Taub.).
Mirabow (*Intsia Bakeri*, Prain; *Afzelia palembanica*, Baker).
Molavé (*Vitex geniculata*, Blanco; *V. littoralis*, Dcne.).
Niri (*Xylocarpus borneensis*, Becc.).
Pagatpat (*Sonneratia Pagatpat*, Blanco; and *S. alba*, Smith).
Ringas (*Melanorrhoea* sp.).
Serayah (*Hopea* sp. or *Shorea leprosula*, Miq.).
Tapang (*Koompassia excelsa*, Taub.).
Teak, Java (*Tectona grandis*, Linn.).
Timidak.
Yacal (*Shorea* sp.).
Yang (*Dipterocarpus tuberculatus*, Roxb. ?).

THE TIMBERS OF EUROPE

Acacia (*Robinia Pseudacacia*, Linn.).
Ailanthus (*Ailanthus glandulosa*, Desf.).
Alder (*Alnus glutinosa*, Gaert.).
Almond, European (*Prunus Amygdalus*, Stokes; *Amygdalus communis*, Linn.).
Apple (*Pyrus Malus*, Linn.).
Ash (*Fraxinus excelsior*, Linn.).
Aspen (*Populus tremula*, Linn.).
Beech (*Fagus sylvatica*, Linn.).
Birch (*Betula alba*, Linn.; *B. lenta*, Linn.).
Boxwood (*Buxus sempervirens*, Linn.).
Briar-root (*Erica arborea*, Linn.).
Cedar (*Cedrus Libani*, Barrel).
Cherry (*Prunus Avium*, Linn.).
Chestnut (*Castanea vulgaris*, Lam.).
Cypress (*Cupressus sempervirens*, Linn.).
Damson (*Prunus domestica*, Linn.).
Elm (*Ulmus campestris*, Sm.).
Elm, Cornish (*Ulmus nitens*, var. *stricta*, Ait.).
Elm, Wych (*Ulmus montana*, Sm.).
Fir, Silver (*Abies pectinata*, DC.).
Holly (*Ilex aquifolium*, Linn.).
Hornbeam (*Carpinus Betulus*, Linn.).
Horse-chestnut (*Aesculus Hippocastanum*, Linn.).
Laburnum (*Laburnum vulgare*, Berch. and Presl.; *Cytisus Laburnum*, Linn.).
Larch (*Larix europoea*, DC.).
Lilac-tree (*Syringa vulgaris*).
Lime (*Tilia cordata*, Miller).
Mulberry (*Morus alba*, Linn., and *M. nigra*, Linn.).
Oak (*Quercus pedunculata*, Ehrh., and *Q. sessiliflora*, Sm.).
Oak, Brown (*Q. Robur*, Linn.).
Oak, Cork (*Q. Suber*, Linn.).
Olive (*Olea europoea*, Linn.).
Pear-tree (*Pyrus communis*, Linn.).
Pine, Red Baltic (*P. sylvestris*, Linn.).
Plane (*Platanus orientalis*, Linn.; *P. acerifolia*, Willd.).
Plum (*Prunus domestica*, Linn.).
Poplar (*Populus alba* and *P. nigra*, Linn.).

Poplar, Grey (*P. canescens*, Sm.).
Service-tree (*Pyrus torminalis*, Ehrh.).
Spruce (*Picea excelsa*, Link).
Sycamore (*Acer Pseudoplatanus*, Linn.).
Walnut (*Juglans regia*, Linn.).
Willow (*Salix coerulea*, Smith, and *S. alba*, Linn.).
Yew (*Taxus baccata*, Linn.).

THE TIMBERS OF INDIA, CEYLON AND THE ANDAMAN ISLANDS

Acacia (*Robinia Pseudacacia*, Linn.).
Acacia Catechu, Willd.
A. leucophloea, Willd.
Adenanthera pavonina, Linn.
Adina cordifolia, Hook. f.
Aglaia Roxburghiana, W. and A.
Albizzia odoratissima, Benth.
A. procera, Benth.
Alphonsea ventricosa, Hook. f. and Th.
Amla-ka (*Phyllanthus Emblica*, Linn.).
Anjan (*Hardwickia binata*, Roxb.).
Anogeissus acuminata, Wall.
A. latifolia, Wall.
Artocarpus Lakoocha, Roxb.
Bauhinia retusa, Ham.
Benteak (*Lagerstroemia lanceolata*, Wall.; *L. microcarpa*, Wight).
Bischofia (*Bischofia javanica*, Blume).
Boehmeria rugulosa, Wedd.
Bombax insigne, Wall.
Boxwood, East Indian (*Canthium didymum*, Roxb.).
Bursera serrata, Colebr.
Calophyllum spectabile, Willd.
C. tomentosum, Wight.
Carallia-wood (*Carallia integerrima*, DC.).
Carapa moluccensis, Lam.
Careya arborea, Roxb.
Cassia Fistula, Linn.
Cedar, Moulmein (*Cedrela Toona*, Roxb.).
Cedar, Red (*Acrocarpus fraxinifolius*, Wight).
Cedar, True, or Deodar (*Cedrus Deodara*, Loudon).
Chaplash (*Artocarpus Chaplasha*, Roxb.).
Chickrassia tabularis, A. Juss.
Cordia fragrantissima, Kurz.
Coromandel-wood (*Diospyros quaesita*, Thw.).
Cotton-wood (*Bombax malabaricum*, DC.).
Cupressus torulosa, Don.
Dalbergia cultrata, Grah.
D. Oliveri, Gamble.
Ebony (*Diospyros Ebenum*, Koenig, and *D. Melanoxylon*, Roxb., etc.).
Ebony, Burmese (*Diospyros burmanica*, Kurz).
Elm, Indian (*Holoptelea integrifolia*, Planch.).

Eng or In (*Dipterocarpus tuberculatus*, Roxb.).
Eriolaena Candollei, Wall.
Fagraea fragrans, Roxb.
Filicium dicipiens, Thw.
Gangaw (*Mesua ferrea*, Linn.).
Garuga pinnata, Roxb.
Gluta travancorica, Bedd.
Grewia tiliaefolia, Vahl.
Gum, Blue (*Eucalyptus Globulus*, Labill.).
Gumbar (*Gmelina arborea*, Roxb.).
Gurjun (*Dipterocarpus turbinatus*, Gaert. f.).
Hopea parviflora, Bedd.
H. Wightiana, Wall.
Ingyin (*Pentacme suavis*, A. DC.).
Jak-wood (*Artocarpus integrifolia*, Linn. f.).
Jamba (*Xylia xylocarpa*).
Jarul (*Lagerstroemia Flos-Reginae*, Retz).
Karawe (*Cinnamomum inunctum*, Meissn.).
Kokan or Lampatia (*Duabanga sonneratioides*, Ham.).
Kydia calycina, Roxb.
Lagerstroemia hypoleuca, Kurz.
Lancewood, Moulmein (*Homalium tomentosum*, Benth.).
Laurel, The Alexandrian (*Calophyllum Inophyllum*, Linn.).
Leza-wood (*Lagerstroemia tomentosa*, Presl.).
Mahwa (*Bassia latifolia*, Roxb.).
Marblewood, Andaman (*Diospyros Kurzii*, Hiern.).
Melanorrhoea usitata, Wall.
Melia composita, Willd.
M. dubia, Hiern.
M. indica, Brandis.
Michelia Champaca, Linn.
M. excelsa, Bl.
Millettia pendula, Benth.
Mimusops Elengi, Linn.
M. littoralis, Kurz (Bullet-wood).
Mirabow (*Intsia Bakeri*, Prain ; *Afzelia palembanica*, Baker).
Morus laevigata, Wall.
Oak (*Quercus spicata*, Smith, etc.).
Odina Wodier, Roxb.
Padauk, Andaman (*Pterocarpus dalbergioides*, Roxb.).
Padauk, Burma (*P. macrocarpus*, Kurz).
Parashorea stellata, Kurz.
Pentace Griffithii, King.
Pine, Blue (*Pinus excelsa*, Wall.).
Pine, Long-leafed (*Pinus longifolia*, Roxb.).
Planchonia Andamanica, or Red bombwe.
Plum, Black (*Eugenia Jambolana*, Lam.).
Podocarpus neriifolia, Don.
Pterocarpus Marsupium, Roxb.
Pterospermum acerifolium, Willd.
Pyinkado (*Xylia dolabriformis*, Benth.).
Red Sanders (*Pterocarpus santalinus*, Linn. f.).
Rosewood, East Indian, or Bombay blackwood (*Dalbergia latifolia*, Roxb.).

Saccopetalum tomentosum, Hook. f. and Th.
Sain (*Terminalia tomentosa*, W. and A.).
Sal (*Shorea robusta*, Gaert. f.).
Sandal-wood (*Santalum album*, Linn.).
Sandan (*Ougeinia dalbergioides*, Benth.).
Sarcocephalus cordatus, Miq.
Satinwood, Andaman (*Murraya exotica*, Linn.).
Satinwood, East Indian (*Chloroxylon Swietenia*, DC.).
Schrebera swietenioides, Roxb.
Schima Wallichii, Choisy.
Sissoo (*Dalbergia Sissoo*, Roxb.).
Snakewood, Indian (*Strychnos colubrina*, Linn., and *S. nux-vomica*, Linn.)
Spondias mangifera, Pers. (The Hog Plum).
Spruce, Himalayan (*Picea Morinda*, Link).
Stephegyne parvifolia, Korth.
Stereospermum chelonoides, DC.
S. xylocarpum, Wight.
Sundri (*Heritiera minor*, Roxb.).
Teak (*Tectona grandis*, Linn.).
Terminalia Arjuna, Bedd.
T. bialata, Wall.
T. Catappa, Linn. (The Indian Almond).
T. Chebula, Retz.
T. Manii, King.
T. procera, Roxb.
Thespesia populnea, Corr.
Thingan (*Hopea odorata*, Roxb.).
Thitka (*Pentace burmanica*, Kurz).
Trincomali-wood (*Berrya Ammonilla*, Roxb.).
Vitex glabrata, Br.
V. Leucoxylon, Linn. f.
V. pubescens, Vahl.
Walnut (*Juglans regia*, Linn.).
Walnut, East Indian (*Albizzia Lebbek*, Gamble).
Zizyphus Jujuba, Lam.

THE TIMBERS OF JAPAN AND FORMOSA

Acacia (*Robinia Pseudacacia*, Linn.).
Alder (*Alnus maritima*, Nutt., var. *formosana*, Burhill).
Ash (*Fraxinus mandschurica*, Rupr.).
Beech (*Fagus sylvatica*, Linn., var. *Sieboldi*, Maxim.).
Birch (*Betula Maximowiczei*, *B. ulmifolia*, *B. alba*, Linn., var. *vulgaris*, DC.).
Bischofia (*Bischofia javanica*, Blume).
Camphor-wood, Formosan (*Machilus Thunbergii*, S. and Z.).
Camphor-wood, True (*Cinnamomum Camphora*, Nees and Eberm.).
Castanopsis brevi-spina, Hay.
Cedar, Formosan (*Chamaecyparis formosensis*, Mats.).
Cushimucho (*Michelia compresa*, Max.).
Hinoki, Formosan (*Chamaecyparis obtusa*, S. and Z.).
Hinoki, Japanese (*Cupressus obtusa*, Koch).
Horse-chestnut (*Aesculus turbinata*, Bl.).

Ichii-gashi (*Quercus Gilva*, Bl.).
Kaki (*Diospyros Kaki*, Linn. f.).
Katsura (*Cercidiphyllum japonicum*, S. and Z.).
Keyaki (*Zelkowa acuminata*, Pl.).
Kiri (*Paulonia tomentosa*, Thunb.; *P. imperialis*, S. and Z.).
Kuren (*Melia japonica*, Don).
Machilus Blumeai, Hay.
Maple, Japanese (*Acer palmatum*, Thunb.).
Oak (*Quercus pseudo-myrsineaefolia*, Hay, etc.).
Oak, Holly (*Q. Morii*, Hay).
Oak, Japanese (*Q. grosseserrata*, Bl.; *Q. crispula*, Bl., etc.).
Pasania or Pasinia (*Q. Junghuhuii*, Miq.).
Pine, Japanese Red (*Pinus densiflora*, S. and Z.).
Riugan (*Pametia pinnata*, Forst.).
Shira-gashi (*Quercus Vibrayeana*, Fr. and Sav.).
Sophora (*Sophora japonica*, Linn.).
Spruce (*Abies Mariesii*, Mast., and *Picea ajanensis*, Fisch.)
Sugi (*Cryptomeria japonica*, Don).
Tsuga (*Tsuga Sieboldi*, Carr.).
Walnut, Manchurian (*Juglans mandschurica*, Maxim.).
Willow (*Salix Urbaniana*, Von Seemen).

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NOTES

NOTE A

Esparvie (p. 148)

Since writing my report on the cargo of esparvie (p. 148) and the resulting lawsuit, Mr. Williams has told me of an interesting occurrence which appears to be worthy of note. The timber was stacked spread over a considerable area of land at Astoria, near New York, and the first indication of any trouble was the surprising visit of a great number of swallows, which were seen to be circling over and about the piles, a hitherto unknown occurrence. Attention having thus been drawn to the timber, small heaps of sawdust were discovered lying beside the logs and planks, while further examination showed the terrible ravages of the attack of the destructive beetle.

This curious circumstance suggests the need for further enquiry and points to the value and importance of scientific research, for the ordinary timber man is quite uninformed on such questions. Was this damage done by some kind of flying beetle or by a grub ? Was the wood already destroyed before the swallows arrived, or did their presence in some way affect the beetle ? Investigation might bring to light some method by which timber could be protected and similar damage prevented.

NOTE B

Locust (p. 163)

I think it most probable that my informant who gave the name of " locus " to the produce of *Dicorynia Maraensis* was confusing it with that of the locust (*Hymenoe Courbaril*) of St. Vincent (*q.v.*), which is a totally different timber. There is, however, sufficient similarity between the two woods to account for any confusion which may have arisen.

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